BALDWIN

OPERATOR'S MANUAL

DIESEL · ELECTRIC LOCOMOTIVES

SEABOARD AIR LINE

THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA, U. S. A.

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CF 1276
MADE IN U.S.A.

BALDWIN

OPERATOR'S MANUAL

NO. DP-106

DIESEL-ELECTRIC

PASSENGER LOCOMOTIVE

* * *

SEABOARD AIR LINE RAILWAY

Road No. 2700 - 2702
BLW No. SC-A 5-6-7

* * *

THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA, PENNA., U.S.A.

BALDWIN

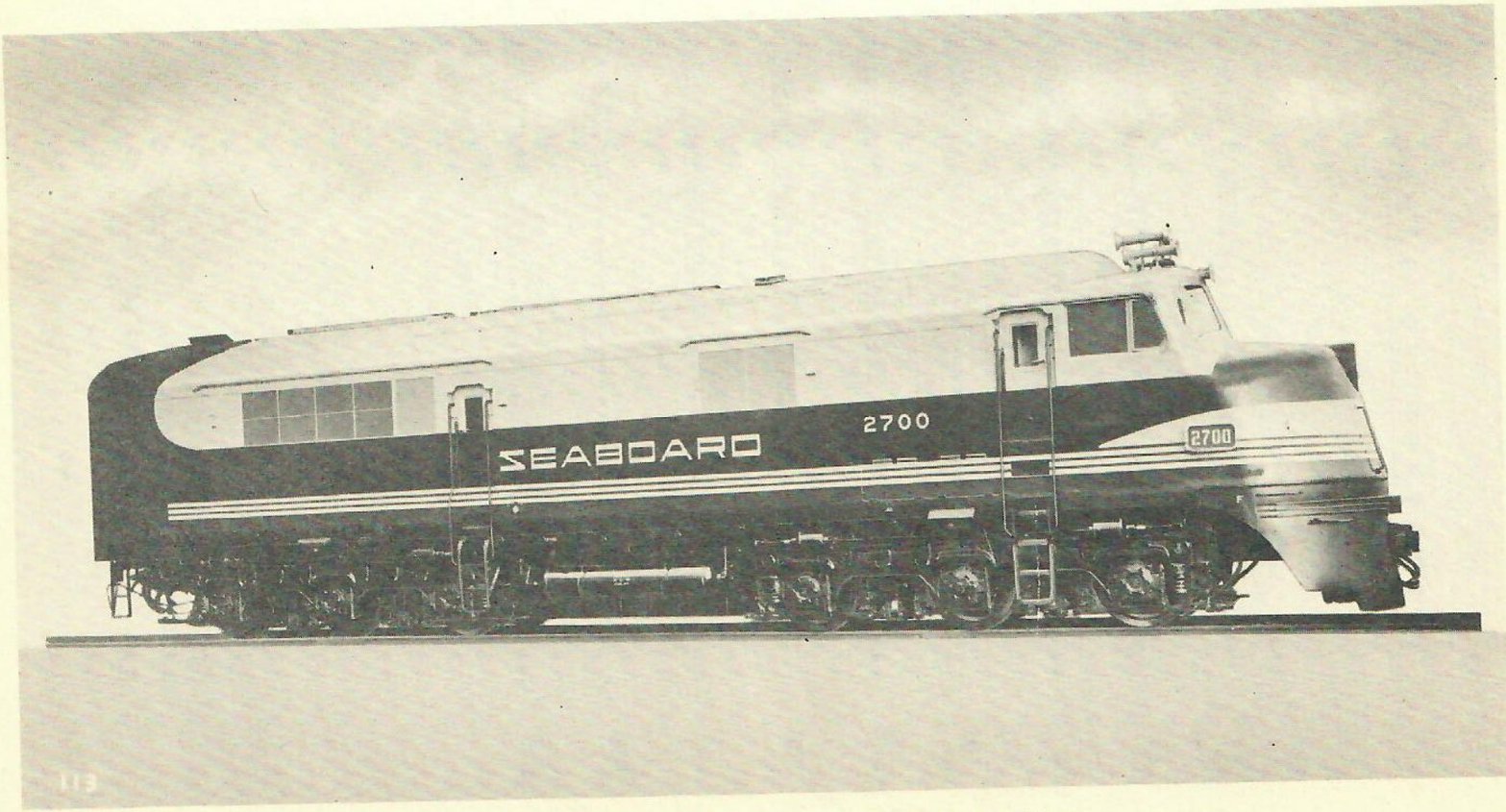
PREFACE

This manual is designed to describe operation of the locomotive and miscellaneous auxiliary equipment. It is divided into sections, which are largely independent of each other. This permits a study of the book according to requirements of various operatives.

Operating personnel, including engineers, firemen and hostlers, should become thoroughly familiar with Sections 1, 2 and 8. The material treated in the remaining sections, affords a broad, general understanding of problems not encountered in routine operation, but which are nevertheless part of an operating manual, since need for such data may arise enroute.

Detailed information normally useful only in shops is omitted and is covered in separate maintenance publications.

Operating rules issued by the railroads, imposing more rigid limitations, take precedence over recommendations contained in this manual.



VIEW OF LOCOMOTIVE - SEABOARD AIR LINE RAILWAY
Figure 1

TABLE OF CONTENTS

	PAGE
TABLE OF CONTENTS.....	1
LIST OF ILLUSTRATIONS.....	2
GENERAL DESCRIPTION.....	4
GENERAL DATA.....	101
INSTRUMENTS, CONTROLS AND OPERATION.....	201
DIESEL ENGINE.....	301
ELECTRICAL EQUIPMENT.....	401
AIR SYSTEM.....	601
STEAM GENERATOR.....	801

Contents of each section will be found at beginning of section.

LIST OF ILLUSTRATIONS

Fig. Page

1. View of Locomotive ..... Frontispiece

GENERAL DATA

1. Locomotive - Arrangement of Equipment 103
2. Locomotive Dimensions - Locations of Fills and Drains 105

INSTRUMENTS, CONTROLS AND OPERATION

1. Engineer's Position 202
2. Fireman's Position 206
3. Radiator Compartment 207
4. Engine Control Panel 208
5. Hostler's Position 210

DIESEL ENGINE

1. Overspeed Stop 302
2. Shutter Operation for Temperature Control .. 304
3. Winter Operation 306
4. Engine Cooling System Diagram 307
5. Low Lube Oil Shutdown Device 311
6. Engine Lubricating Oil System Diagram 313
7. Engine Fuel Oil System Diagram 317

ELECTRICAL EQUIPMENT

Fig. Page

1. Control System Diagram 402
2. Simplified Schematic Wiring Diagram 405
3. Main Generator and Traction Motor 408
4. Equipment Cabinet - "A" Unit 411
5. Equipment Cabinet - "B" Unit 413
6. Main Power Circuit 417
7. Main Control Circuit 423
8. Auxiliary Power Circuit 425
9. Auxiliary Control Circuit 429
10. Miscellaneous Circuits 433
11. Battery Circuit 436
12. Lighting Circuit 441
13. Steam Generator Circuit (Vapor) 443

AIR SYSTEM

1. Air Piping - Schematic Diagram - "A" Unit. 607
2. Air Piping - Schematic Diagram - "B" Unit. 609

STEAM GENERATOR (VAPOR)

1. Remote Control Panel 802
2. Steam Generator Operating Controls 805
3. Views of Steam Generator 809
4. Steam Generator - Schematic Diagram 811

GENERAL DESCRIPTION

This locomotive is a single "A" type unit, 1500 HP, Diesel Electric type, powered by an 8-cylinder, supercharged, four-cycle engine, with direct connected main generator. The locomotive is a class 0-6-6-0 design, with two three-axle trucks. A traction motor is mounted on each outside axle of both trucks. The four traction motors are driven by the engine generator set.

"A" type units have an engineer's position, a fireman's position and standard locomotive controls; "B" type units have only hostler's controls. A locomotive may consist of an "A" unit operated alone, or to meet changing load conditions, units may be interconnected in "A-A", "A-B" or "A-B-A" combinations.

When two or more units are being operated as a single locomotive, control for all units is handled in one or the other "A" unit cabs. Although control is thus unified, certain specific items are independently controlled on each unit, such as radiator cooling system, fuel supply pumps, starting and stopping of engines, and functioning of certain electrical and auxiliary equipment for the respective power units.

Train speed is a function of locomotive power output and train load. The power of the locomotive is controlled by varying the Diesel engine speed by means of the engineer's throttle in the cab.

The electric transmission produces smooth acceleration at the desired rate with extremely close regulation of locomotive speed. A complete description of the power generating and transmission equipment is contained in the Electrical section.

Energy for starting the engine is obtained from the storage battery which is connected by the starting switch, through relays and starting contactors to the main generator, which acts as a motor during the starting. After the engine is started it is completely controlled by the engineer from the cab.

Engine cooling water and lubricating oil are cooled by radiators, located to the rear, in the roof structure of the locomotive. Air, drawn thru the radiators by large, motor driven fans, carries excess

heat of the water and oil to the atmosphere.

The engine is supercharged by an Elliot-Buchi turbocharger, a self-contained unit, comprising a gas turbine and a centrifugal blower, rotating on a common shaft. The unit is located at the end of the engine over the main generator. Engine exhaust gas is fed to the turbine through four manifold pipes, each of which receives gas from two cylinders.

Detailed description of the operating procedure and the functional purpose of the various pieces of equipment and controls, is contained in the following pages of this instruction.

Arrangement and location of the locomotive equipment is shown in Fig. 1 of this section.

DIESEL ELECTRIC LOCOMOTIVE

SEABOARD AIRLINE RAILWAY

ROAD NO. 2700 - 2702
BLW NO. SC-A 5-6-7

GENERAL DATA

BLW LOCOMOTIVE CLASSIFICATION	DR-6-4-1500/1 SC-A 5-6-7
GAUGE	4' - 8-1/2"
WHEEL ARRANGEMENT	0-6-6-0
Two Six Wheel Swivel Trucks	
DIESEL ENGINE	1500 H.P.
One 1500 HP 8-Cylinder In-Line Supercharged Engine	Model 608 SC
MAIN GENERATORS	Westinghouse
One	480-D
TRACTION MOTORS	Westinghouse
Four	370-F
Gear Ratio, Armature to Axle	15-63
STEAM GENERATOR	Vapor-Clarkson
1600 Lbs. per Hour Output	DK-4516
TRACTIVE EFFORT	
Starting at 25% Adhesion	50,000
MAXIMUM SPEED	65 M.P.H.
CURVES, MINIMUM RADIUS	
Locomotive with Train	274' - 21°
WHEELS	
Driving	4 Pairs
Idle	2 Pairs
Diameter	42"
WHEEL BASE	
Trucks Each	13' - 3"
Locomotive, Total	43' - 9"

LOCOMOTIVE DIMENSIONS

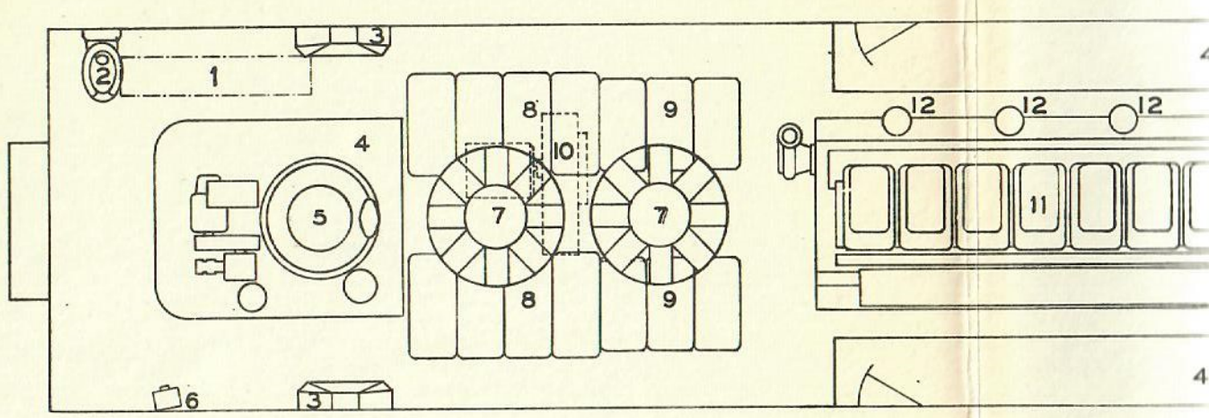
Length, Inside Coupler Knuckles	61' - 0"
Height, Maximum Overall	14' - 7-3/8"
Width, Maximum Overall	10' - 6"

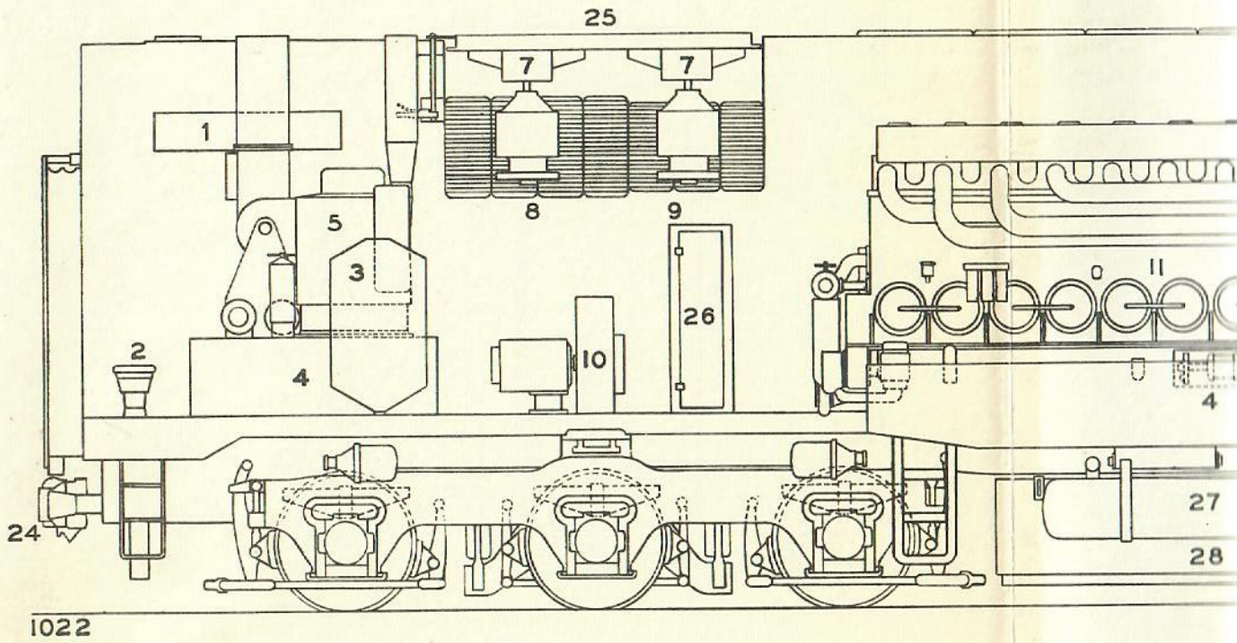
WEIGHTS

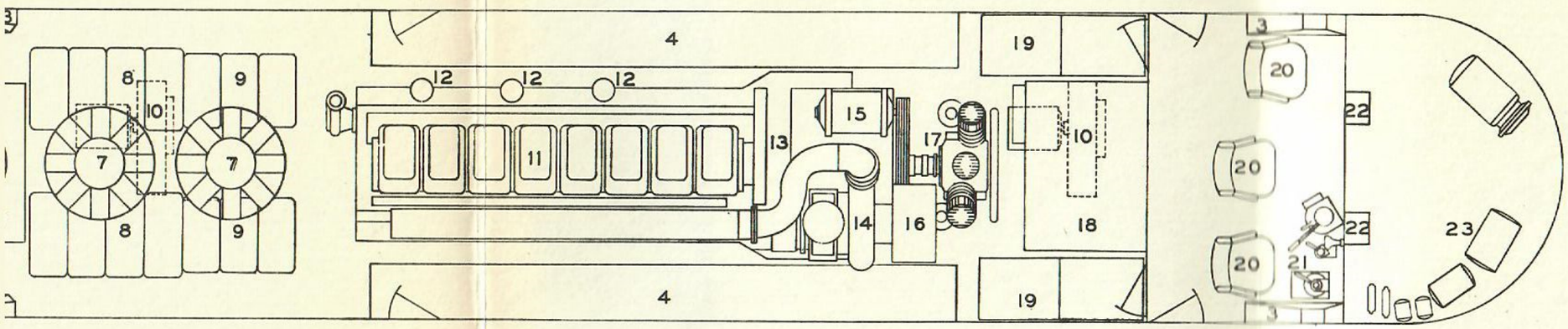
Locomotive, in Working Order	326,500 Lbs.
On Each Axle	
Traction Motor Gear and Axle Bearings	7,370 Lbs.
Pair of Wheels and Gear on Axle with Boxes	5,100 Lbs.
Diesel Engine with Turbocharger	38,500 Lbs.
Main Generator	13,200 Lbs.
Auxiliary Generator and Exciter	800 Lbs.
Diesel Engine Power Unit Complete ..	52,500 Lbs.
Brake Air Compressor	1,300 Lbs.
Steam Generator	3,200 Lbs.
Radiator Fan and Motor Assembly	1,150 Lbs.

SUPPLIES

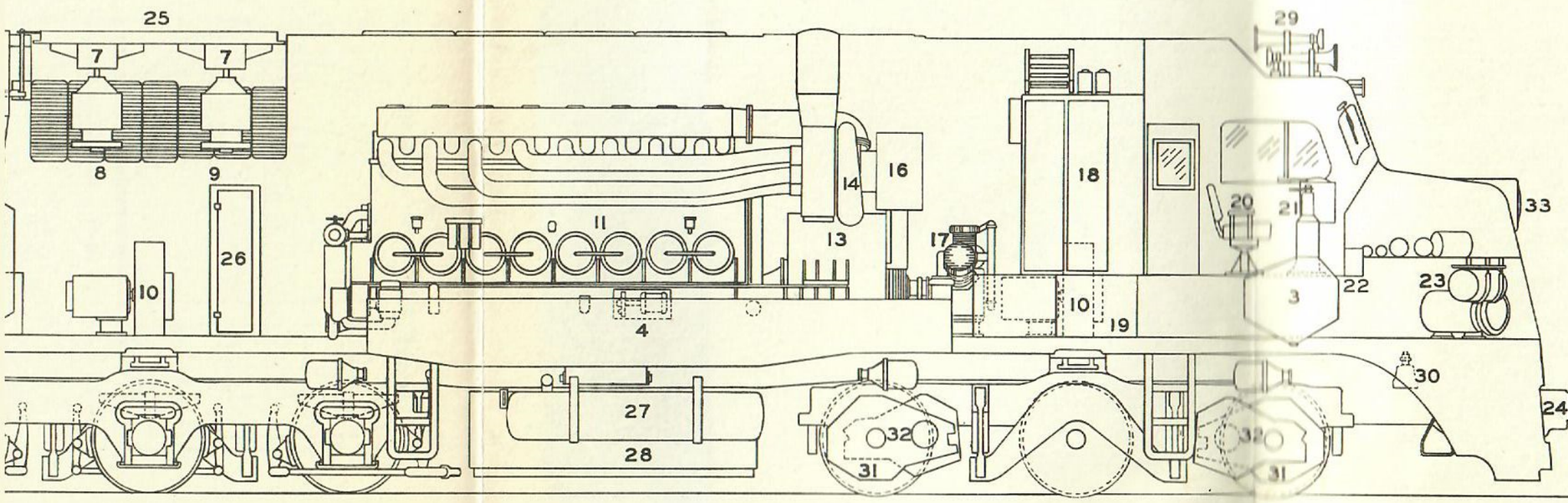
Fuel Oil	1200 Gal.
Engine Lubricating Oil	135 Gal.
Engine Cooling Water	300 Gal.
Water for Steam Generator	1200 Gal.
Air Compressor Lubricating Oil	14 Qts.
Sand	30 Cu. Ft.

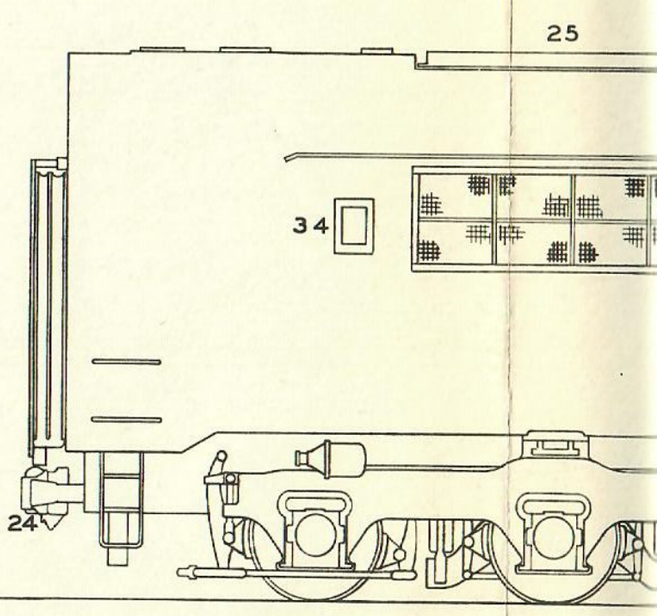




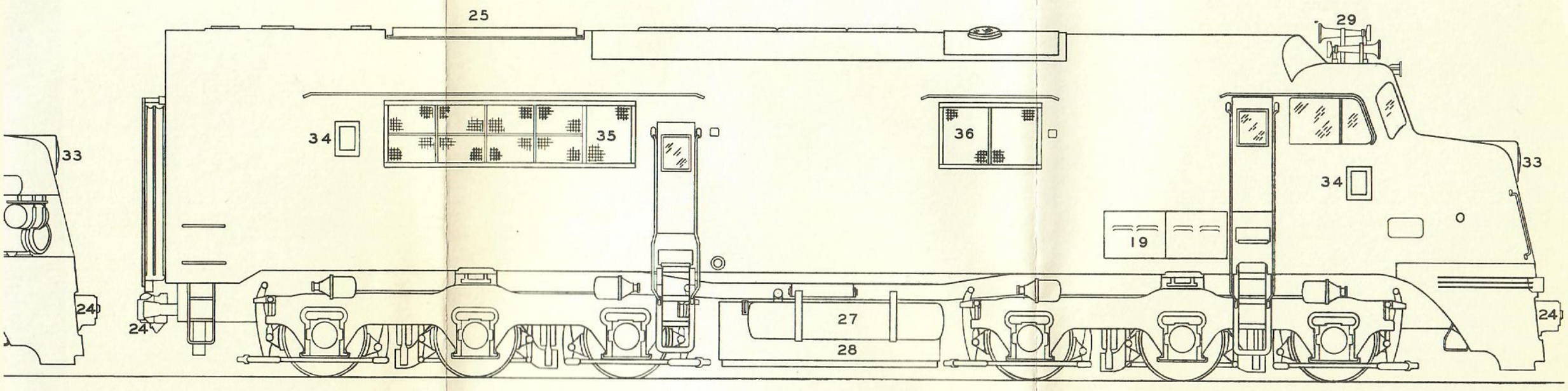


1. Sanitary Water Tank
2. Toilet
3. Sand Box
4. Steam Generator Water Tank
5. Steam Generator
6. Hand Brake
7. Cooling Fan and Motor
8. Radiator - Water
9. Radiator - Lubricating Oil

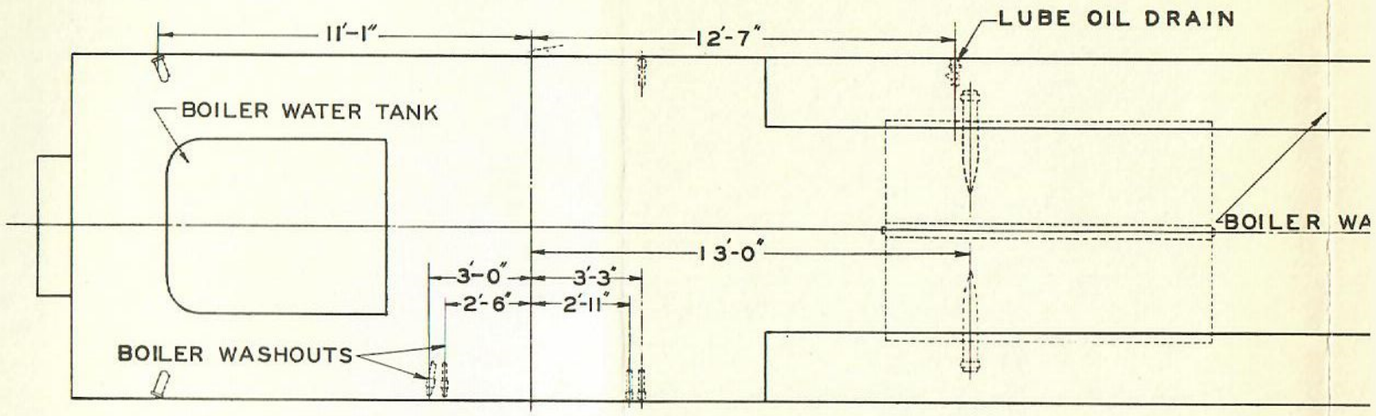


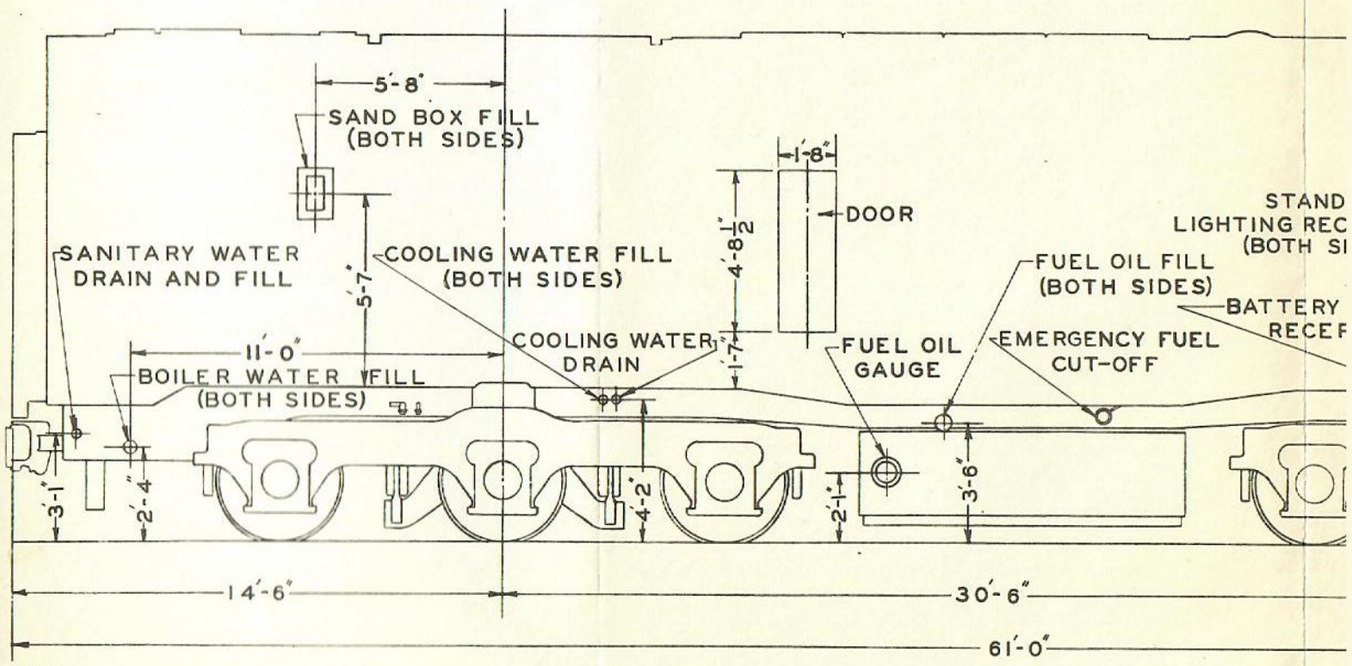


1. Sanitary Water Tank
2. Toilet
3. Sand Box
4. Steam Generator Water Tank
5. Steam Generator
6. Hand Brake
7. Cooling Fan and Motor
8. Radiator - Water
9. Radiator - Lubricating Oil
10. Traction Motor Blower
11. Diesel Engine
12. Lubricating Oil Filter
13. Main Generator
14. Turbocharger
15. Auxiliary Generator and Exciter
16. Turbocharger Filter - Silencer
17. Air Compressor
18. Electrical Equipment Cabinets
19. Battery Box
20. Seat
21. Engineer's Controls
22. Cab Heater
23. Air Brake Equipment
24. Coupler
25. Shutter and Shutter Controls
26. Cabinet
27. Air Reservoir
28. Fuel Tank
29. Horns
30. Bell
31. Traction Motor Gear Case
32. Traction Motor
33. Headlight
34. Sand Filler
35. Cooling Fan Air Intake Filter
36. Engine Air Intake Filter

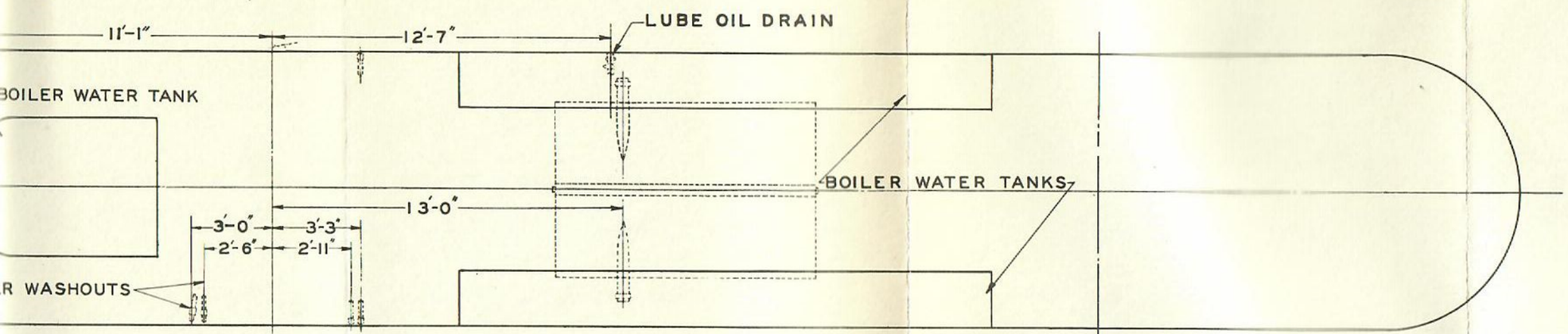


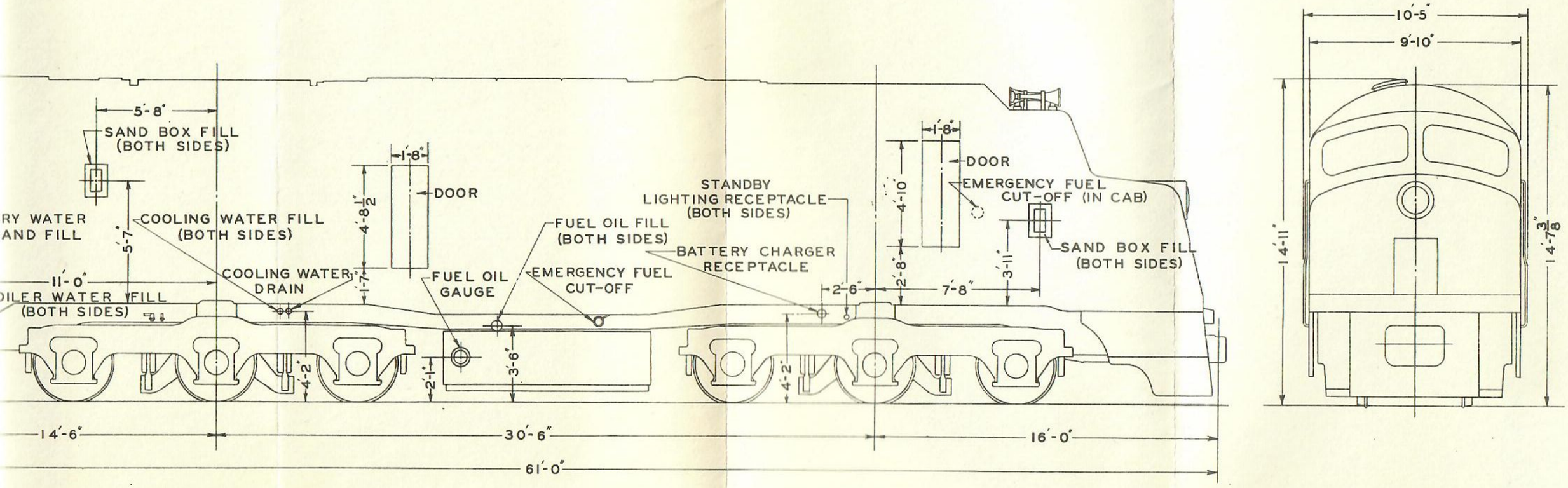
LOCOMOTIVE - ARRANGEMENT OF EQUIPMENT
Figure 1


11'-1"
12'-7"
LUBE OIL DRAIN
BOILER WATER TANK
BOILER WA
13'-0"
3'-0"
3'-3"
2'-6"
2'-11"
BOILER WASHOUTS


5'-8"
SAND BOX FILL
(BOTH SIDES)
1'-8"
DOOR
4'-8½"
STAND
LIGHTING REC
(BOTH SI
SANITARY WATER
DRAIN AND FILL
COOLING WATER FILL
(BOTH SIDES)
5'-7"
FUEL OIL FILL
(BOTH SIDES)
BATTERY
RECEF
11'-0"
BOILER WATER FILL
(BOTH SIDES)
COOLING WATER
DRAIN
1'-7"
FUEL OIL
GAUGE
EMERGENCY FUEL
CUT-OFF
3'-1"
2'-4"
4'-2"
2'-1"
3'-6"
14'-6"
30'-6"
61'-0"

1023



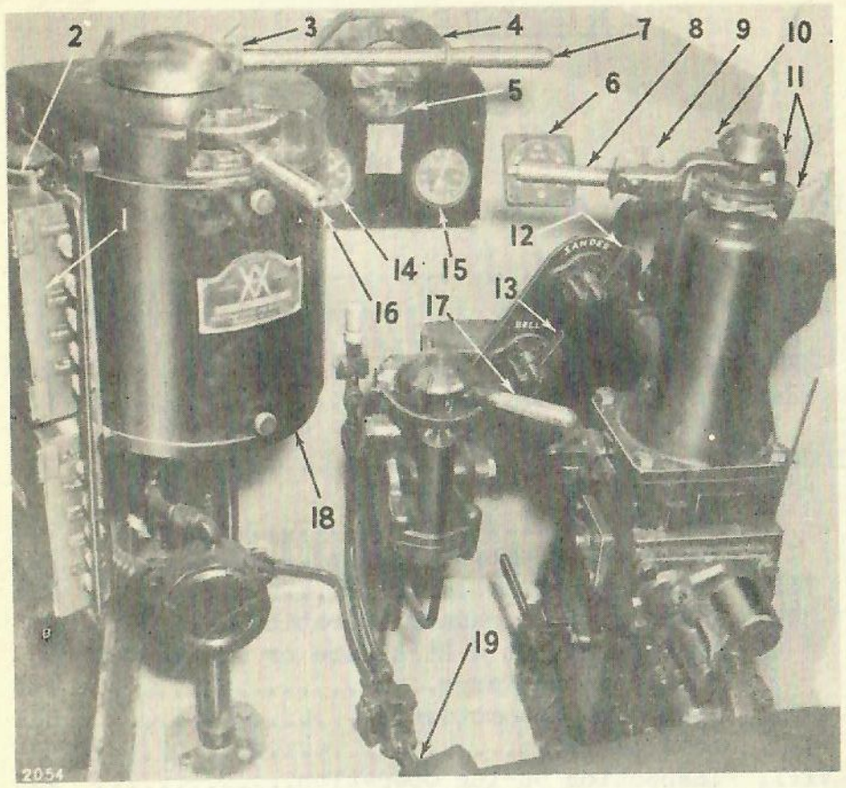


LOCOMOTIVE DIMENSIONS - LOCATION OF FILLS AND DRAINS
Figure 2

INSTRUMENTS, CONTROLS AND OPERATION

CONTENTS

	Page
INSTRUMENTS AND CONTROLS	203
Engineer's Position	203
Fireman's Position	206
Radiator Compartment	207
Engine Room	208
Hostler's Position	209
LOCOMOTIVE OPERATION	211
I. Preliminary	211
II. Inspection Before Starting	211
III. Starting Engine	211
IV. Brake Air Compressor Operation	213
V. To Pump Air at a High Rate or Check Engine Speed Range	213
VI. Operating Locomotive	213
VII. Load Limit	215
VIII. Inspection During Operation	216
IX. To Stop Locomotive	217
X. Emergency Fuel Cut Off Valve	217
XI. To Stop an Engine	217
XII. To Cut Out Traction Motors	217
XIII. Towing Locomotive	218
XIV. Procedure When Leaving Cab	218
XV. Procedure for Multiple Operation	219
XVI. Procedure for Changing Ends	220
XVII. To Cut Out a Power Unit Enroute	220
XVIII. To Start Engine and Put Power Unit Back on Line	220
PRECAUTIONS TO BE OBSERVED	221
HELPFUL HINTS FOR OPERATORS	222
OPERATING DIFFICULTIES AND CAUSES	224



ENGINEER'S POSITION
Figure 1

1. Control Push Button Switch Box
2. Lock for Control Switches
3. Rotair Valve
4. Gauge and Meter Box
5. Ammeter - Engine Generator Unit
6. Speedometer
7. Throttle Lever
8. Automatic Brake Valve
9. Gauge Light Dimmer Switch
10. Heater Switch
11. Air Horn Valve
12. Hand Sander
13. Bell Ringer
14. Brake Pipe and Cylinder Pressure Gauge
15. Main and Equalizing Reservoir Pressure Gauge
16. Reverse Lever
17. Independent Brake Valve
18. Master Controller
19. Deadman Pedal

INSTRUMENTS AND CONTROLS

Instruments and controls necessary for locomotive operation are conveniently located across the front of the engineer's cab and are placed to the left and right according to responsibilities of the engineer and fireman.

Instruments and controls used to start, isolate and stop the Diesel engine are arranged on a control panel mounted on the end of the electrical equipment cabinet. Certain automatic and manual controls are grouped inside the electrical cabinet. Others are situated elsewhere on the locomotive. Functions and operation of these controls will be covered in their proper connection in this manual. After the Diesel engine is started it is completely controlled by the engineer from the cab.

ENGINEER'S POSITION

MASTER CONTROLLER

The master controller, situated in front of and slightly to the left of the engineer's seat, contains the throttle lever and the reverse lever. Locomotive speed is controlled by means of the throttle which regulates engine speed through a pneumatic actuator operating on the speed control shaft of the engine governor. The reverse lever determines direction of rotation of the traction motors (and accordingly of the locomotive) by controlling a pneumatically actuated reversing switch in the traction motor circuit.

CONTROL PUSH BUTTON SWITCH STATION

The control switch station, mounted on the left side of the master controller, incorporates push button switches as follows:

1. Lock for Control Switch Station
2. Control
3. Spare
4. Attendant
5. Defroster
6. Engine Shutdown Switch
7. Nose Lights
8. Rear Headlights
9. Gauge and Number Lights

10. Classification Lights
11. Marker Lights

BRAKE PEDESTAL

The automatic brake valve is mounted in a pedestal in front of the engineer, with the lever advantageously located at his right hand, affording quick control of brakes for the entire train.

The independent brake valve, located between the automatic brake valve and the master controller, is mounted on a bracket secured to the brake pedestal. This valve controls locomotive braking only.

DEADMAN FOOT PEDAL

Located on the floor convenient to the engineer's left foot, is the deadman pedal, which must be depressed continously while the locomotive is in operation. If this pedal is released during operation the brakes will automatically be applied for a service stop, and the engines brought to idle speed. Before this operation takes place, however, a warning whistle will sound, and if the deadman pedal is depressed within a 4 to 6 second period, the operation will be supressed. To release the controls for normal operation after deadman pedal application, depress pedal, place throttle in "off" position and move automatic brake valve handle to "lap" position until the application portion releases.

An air interlock keeps the engines at idling speed until the throttle has been returned to the "off" position.

HAND SANDER VALVE

The hand sander valve is mounted on a bracket to the left of the automatic brake valve. When the sander valve is used, sand is applied to the forward side of the front pair of wheels of each truck. Sand should not be used except under the worst track conditions and then only sparingly. It should be remembered that sand is most injurious to traction motors and to all moving parts of the running gear.

AUTOMATIC SANDER VALVE

Automatic sanders are provided which will apply

sand during an emergency brake application to the same wheels as hand sanding depending on the direction of locomotive movement.

BELL RINGER AND AIR HORN

The bell ringer and air horn valves are located within easy reach of the engineer. The bell ringer is mounted to the left of the automatic brake valve on a bracket with the hand sander valve. The air horn valves are located on the front cab bulkhead to the right of the brake pedestal.

WHEEL SLIP INDICATOR

When one pair of traction wheels slip, a buzzer will sound and the power of the engine involved will be reduced momentarily by a relay system and then increased to the original load. If the buzzer sounds again, the throttle should be retarded to prevent further slippage.

WINDSHIELD WIPERS AND SPEEDOMETER

Windshield wipers are controlled by a valve located on the wiper operating housing. Speedometer is located on the instrument panel to the right of the instrument box.

ROTAIR VALVE

Mounted on the instrument panel to the left of the gauge and meter box, the rotair valve, operated manually, is used to adjust braking power for either passenger or freight service.

HEADLIGHTS

A three-way toggle switch over the engineer's side window turns the headlight on (either dim or bright) and off. "B" units usually have a back-up light, with switch, located at each end of the unit.

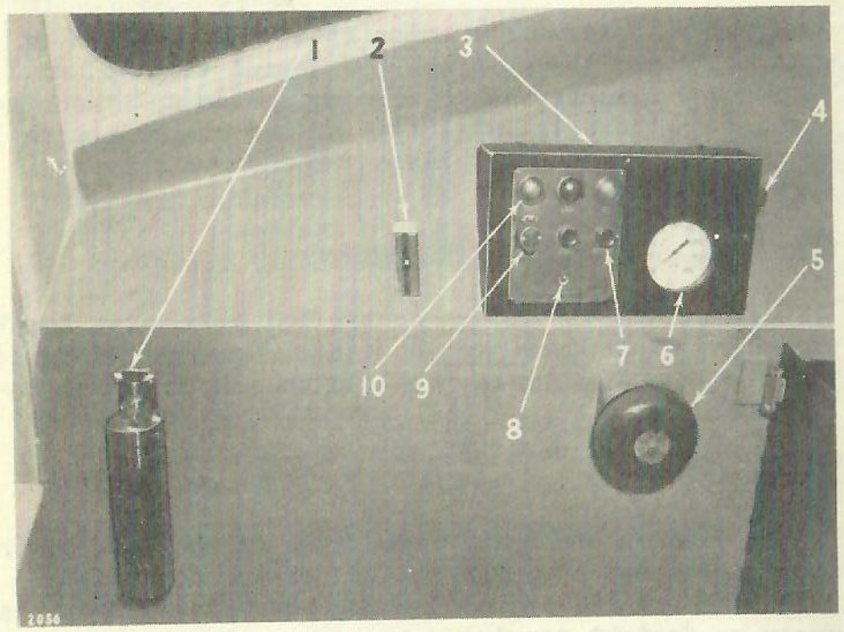
LOAD AMMETER

The load ammeter indicates the amount of power going to the traction motors. It is connected in the traction motor circuit on some locomotives, and in the generator circuit on others.

The connection on any particular locomotive may be determined by reference to a plate showing ampere ratings mounted at the engineer's position and comparing these with data tabulated under "Load Limits" in subsequent paragraph of this section.

FIREMAN'S POSITION

The instruments, controls and signal lights illustrated below, are mounted on the instrument panel in front of the fireman's position on the left side of the cab.



FIREMAN'S POSITION
Figure 2

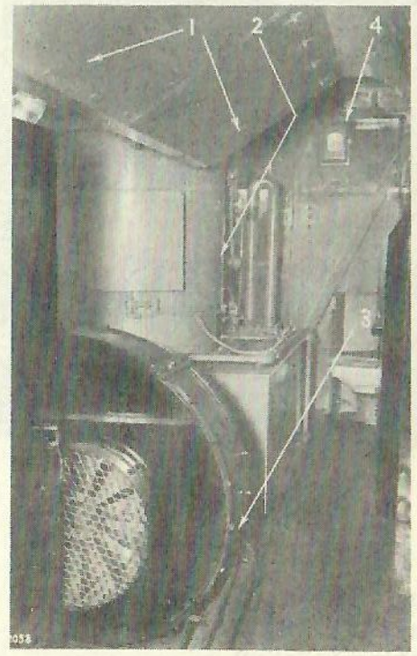
1. Hand Fire Extinguisher
2. Heater Switch
3. Boiler Remote Control Panel
4. Gauge Light Rheostat
5. Alarm Bell
6. Train Line Steam Pressure Gauge
7. Boiler Separator Blow Down Switch
8. Boiler Master Switch
9. Train Line Shut Off Switch
10. Boiler Off, Warning Light

RADIATOR COMPARTMENT

The radiator compartment is located to the rear of the engine in each unit. Engine cooling water and lubricating oil radiators are mounted in this compartment with the motor driven radiator fans. Fans and motors, mounted above the radiators, draw cooling air through the radiators and discharge the hot air through openings in the roof.

One of the two traction motor blowers on each unit is located in the radiator compartment; the other blower is situated just ahead of the air compressor under the electrical equipment cabinets. These blowers are motor driven and supply air for cooling the traction motors. They will start automatically when the Diesel engine is started.

NOTE: An alarm bell and three duplicate warning lights are located on the rear of the engine room.

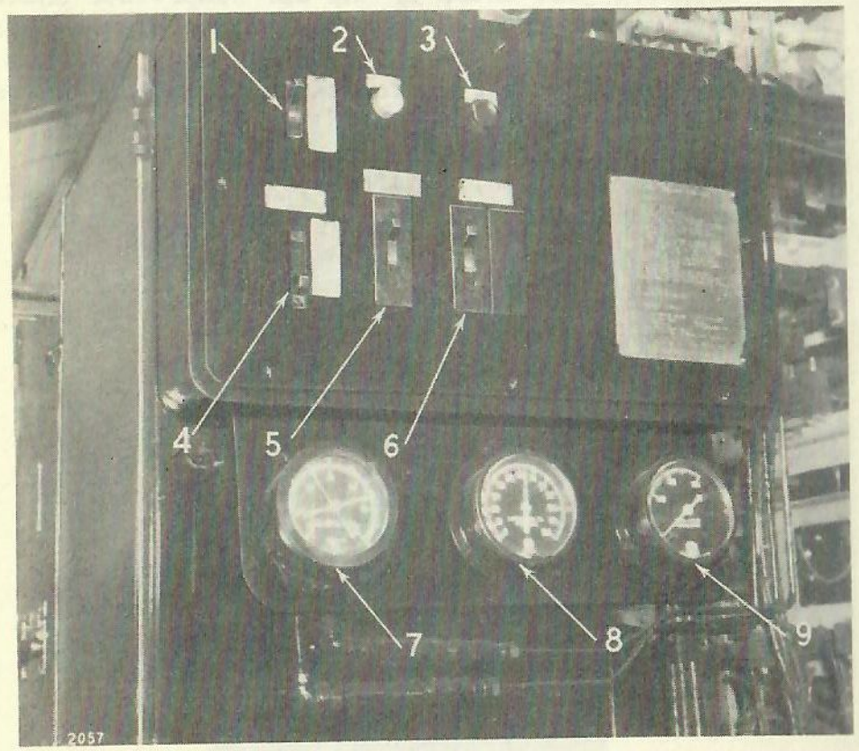


RADIATOR COMPARTMENT
Figure 3

1. Radiators for Cooling Water and Lube Oil
2. Steam Generator 3. Traction Motor Blower
4. Steam Generator Main Switch

ENGINE ROOM

The instruments and controls necessary to start, stop and isolate the engine on each unit of this locomotive, are arranged on an instrument panel mounted on the end of the electrical equipment cabinet. Warning lights will light on the affected unit or units only, but an alarm bell sounds in the engine room of all units and in the cab of controlling unit. Switches and gauges included on the panel are listed on following page.



ENGINE CONTROL PANEL
Figure 4

1. Isolating Switch
2. Start Button, No. 1
3. Start Button, No. 2
4. Fan and Shutter Switch
5. Fuel Pump Switch
6. Engine Stop Switch
7. Fuel Oil Pressure Gauge
8. Lube Oil Pressure Gauge
9. Water Temperature Gauge

HOSTLER OPERATION - "B" UNIT

Designed and equipped for multiple operation, with at least one "A" unit, independent movements of the "B" unit is generally confined to necessary handling by a hostler around terminals and roundhouses.

HOSTLER'S POSITION

CONTROLS

"B" units are fitted with instruments and controls at the hostler's position for independent operation. The throttle valve has a lever for regulating speed of the unit when operated alone. The reverser drum is equipped with a reverse lever for controlling direction of rotation of the traction motors, and consequently the direction of movement of the unit in independent operation.

CONTROL PUSH BUTTON SWITCH STATION

Conveniently mounted at the hostler's position is the control switch station, equipped with push button switches whose use can be determined by the name plate at each push button.

A lock for the control switches is mounted on the control switch station. Operator should turn key to locked position and remove it when he leaves the unit or when unit is operated in multiple.

BRAKE VALVE

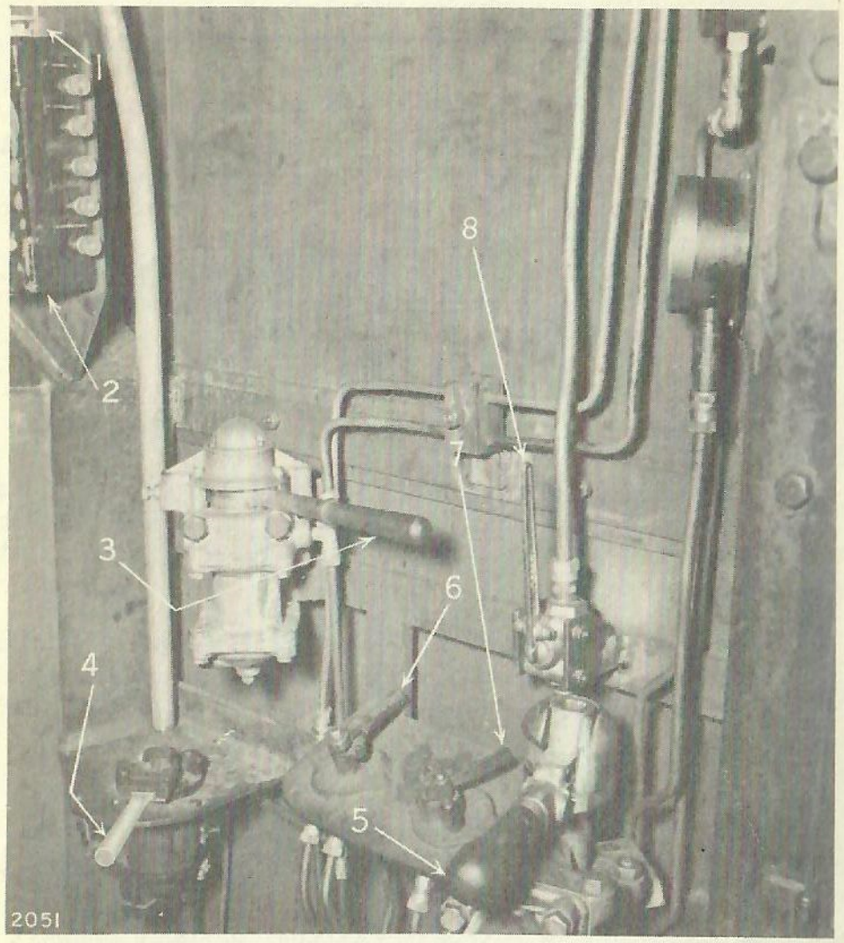
To the right of the hostler's position is the brake valve, which is mounted on side wall of the unit. The brake valve controls brakes for the "B" unit when it is operated independently. When the unit functions as a component unit of a locomotive, these brakes become part of the braking system.

HAND SANDER

Mounted on a sloping bracket secured to the wall in front of the brake valve, the hand sander valve is operated by moving the valve handle. Sand is applied to either the leading or trailing wheels on both sides of each truck, depending upon the direction of travel of the locomotive.

BELL RINGER AND AIR HORN

Bell ringer and air horn valves are located within easy reach of the hostler. Bell ringer is mounted back of and on the same bracket with the hand sander. Air horn valve is mounted just above the brake valve.



HOSTLER'S POSITION
Figure 5

1. Lock for Control Switches
2. Control Push Button Switch Station
3. Throttle
4. Reverse Lever
5. Brake Valve
6. Bell Ringer
7. Hand Sander Valve
8. Air Horn Valve

L O C O M O T I V E O P E R A T I O N

Operation of the locomotive should be in accordance with the following instructions. Equipment referred to can be located by consulting the General Arrangement drawing on page 103 and by referring to illustrations found in the Operation section of this manual.

I. PRELIMINARY

A. To light cab lights:

The lights in the engineer's cab can be turned on by means of the toggle switch adjacent to either cab door, also by switches over the engineer's and fireman's side windows. The battery switch in the electrical cabinet must be closed before these lights will light.

B. To light engine room lights:

The engine room lights can be turned on by means of switches at cab doors and at rear door. These switches will not operate unless master switch in the electrical equipment cabinet and the battery switch are closed.

II. INSPECTION BEFORE STARTING

A. Check supplies

1. Fuel
2. Engine crankcase and governor oil levels
3. Air compressor and crankcase oil levels
4. Engine water level
5. Sand
6. Boiler water supply tank

B. Drain condensate from air reservoirs

C. Check that battery is not connected to an outside source of power unless the outside circuit can carry the heavy current involved.

III. STARTING ENGINE

A. At master controller in engineer's cab

1. Place throttle in "off" position; place reverse

lever in "off" position.
2. Unlock control push button switch station.
3. Close control push button switch. This is the top switch of the group mounted on the side of the master controller.

B. At electrical equipment cabinet.

1. Check that auxiliary generator switch is in "off" position.
2. Close battery switch.

C. At engine control panel

1. Check that the radiator fan and shutter switch is in the automatic position.
2. Close fuel supply pump switch.
3. Close engine shutdown switch; when this switch is closed an alarm bell will ring continuously until the engine is started.
4. Press engine start button, step No. 1

This should crank the engine. Continue cranking until engine fires and lube oil pressure exceeds 20 pounds; then release the start button. If start button is released before the oil pressure reaches 20 pounds, the engine will automatically be stopped by the oil pressure switch.

If the engine does not turn fast enough to start, press start button, step No. 2, to increase cranking speed. The engine cannot be started by pressing No. 2 button alone. Press No. 1 first and allow engine to turn a few revolutions before pressing No. 2. No. 1 must be held in contact continuously while pressing No. 2.

CAUTION: If the engine fails to start within 10 seconds, release the start button and determine the reason for not starting. See "Operating Difficulties" at end of book.

5. Place isolating switch in "on" position.

D. At electrical equipment cabinet

6. Charge battery by closing the auxiliary generator switch. The battery charging ammeter will register a current of between 5 and 50

amperes on starting and approach zero as the batteries become fully charged.
7. Close power cut out switches if open.
8. If unit is being operated in multiple, check that controlled units are properly cut out. See Section XV.

IV. BRAKE AIR COMPRESSION OPERATION

The air compressors are directly connected to the engine and will start pumping air when the engines are started. The air pressure gauge should be checked to see that the pressure is building up correctly.

When the air reservoir pressure reaches 140 pounds, the compressor governor will operate an unloading valve and prevent further delivery of air to the reservoir. When the pressure drops to 125 lbs., the compressor will resume delivery of air to the reservoirs. As the reservoir pressure builds up, check that the control air pressure is 70 pounds. This pressure will register on a gauge located in the nose compartment of the locomotive.

V. TO PUMP AIR AT A HIGH RATE OR CHECK ENGINE SPEED RANGE

The Diesel engine speed can be increased to pump air at a high rate or to check its speed range in the following manner:

With the reverse lever on the master controller in the "off" position (and the control push button switch closed), notch out slowly on the throttle lever. After 40° to 45° of movement the engine speed will increase. Continue to advance throttle to engine speed desired, or to attain pumping rate required.

VI. OPERATING LOCOMOTIVE

A. Inspection before starting locomotive

1. Check application and release of brakes, using independent and automatic brake valves.
2. Check fuel and lubricating oil pressure.
3. Check engine cooling water temperature.
4. Check horn and bell ringer operation.
5. Check that main air reservoir pressure is 140 pounds.

6. Check that control air pressure is 70 pounds.
7. Release all hand brakes.
8. Check that traction motor cut out switches are closed.
9. Check that traction motor blowers are operating.

   The locomotive must not haul a train unless the blowers are operating. A warning light, located on the side of the electrical equipment cabinet, flashes on if blowers stop while engines are running, or if blowers fail to start when engines are started.

10. Check radiator fans and shutters for correct operation. If water temperature is above 160°, the shutters should be wide open and the fans operating.

B. To move locomotive

1. Insert reverse lever and place it in position required for the direction in which the locomotive is to be moved.
2. Place foot on deadman pedal. Release air brakes.
3. Move throttle lever slowly away from "off" position to first notch and hold until ammeter indicates that current is flowing to the traction motors. This will take about four seconds.
4. When the ammeter registers current, stretch the train with as little throttle advance as possible to promote smooth handling, then advance the throttle to the position required for the desired train acceleration. The throttle lever should be notched out slowly (20 to 25 seconds to full throttle) without fanning, keeping within the load limits (see Section VII) and avoiding wheel slip if possible. When the desired train speed has been reached, back off on the throttle if necessary.
5. Buzzer will sound if wheel slip occurs, and speed of engine powering the truck concerned will automatically decrease until slipping stops. Engine will then return to its former speed, also automatically. If wheel slip recurs, move throttle toward "off" until wheel slip stops.

Do not apply sand while wheels are slipping. Back off on throttle first. Sand is a preventive, not a corrective measure.

6. Two steps of automatic field shunting occur as the locomotive speed increases. These changes in field shunting are accompanied by a sudden increase in ammeter readings and take place at a speed of approximately 32 and 48 miles per hour.

VII. LOAD LIMIT

Electrical equipment is subject to definite load (current) limitations due to the detrimental effect of excess current and heat on insulation and wiring. Disregard of the load limitations weakens the insulation sufficiently to cause failure at a later time even if the equipment does not fail at the time of the overload. The continuous rating of the generator is 1800 amperes. There is not time limit for operation at or below 1800 amperes.

Electrical equipment will safely carry overloads for a limited time provided the maximum allowable temperature has not yet been reached. If the locomotive has been operating at its continuous rating for 1 hour or more, no overload capacity exists. If the time limit has been used on any overload, no further overload capacity exists at any amperage.

During acceleration, loads up to 3600 amperes may occur. If the equipment is cool, any one of the following overloads may be carried for a time, up to the time limit specified in this table.

GENERATOR AMPERES	TIME LIMIT
1800	No limit
2000	40 minutes
2200	20 minutes
2600	10 minutes
3000	6 minutes
3600	4 minutes

Whenever any of the foregoing limits is reached, the throttle must immediately be retarded sufficiently to reduce the load to the continuous rating. No time is available for operation on any other load above the 1800 ampere continuous rating.

On grades, it is generally not possible to carry overloads for the times just specified. If the equipment has been operating near its continuous rating, or has recently carried an overload, no further overload capacity exists because the equipment does not have the benefit of a cool start. It will be necessary to stop the train for cooling if heavy overload is experienced for an appreciable time because reducing the throttle will not reduce the current. (There may be temporary changes in current if the automatic field shunt connections change. See "Traction Motor Field Shunt Relays" in Electrical Section.) It is therefore more advantageous to refrain from hauling tonnage which is in excess of the maximum tonnage specified by the railroad for each type of motive power thru a specific district. Such maximum tonnage may impose limited overloads which, if properly set up, constitutes acceptable normal operation. If there is any deviation from normal operation the crew should limit the load to the continuous rating. Typical deviations would be (a) double-heading with a steam locomotive in which case the Diesel locomotive may tend to take more than its share of the load, or (b) operation with one power unit shutdown or isolated, in which case train tonnage should be reduced proportionately on the ruling grades, or (c) accumulation of an indefinite volume of tonnage if additional cars are picked up enroute.

VIII. INSPECTION DURING OPERATION

A. Check that engine water temperature, automatically controlled by radiator shutters and electrically driven fans, is between 151° and 158°. If automatic controls fail, the temperature must be controlled manually. See page 305.

B. Check that engine lubricating oil pressure is maintained at 65 pounds. Investigate promptly any perceptible deviation from 65 pounds pressure at rated speed. See page 309.

C. Check that engine fuel oil is held at 25 pounds pressure. Investigate any loss in fuel pressure at once. See page 316.

IX. TO STOP LOCOMOTIVE

A. Normal procedure:

1. Move throttle to first running position and hold a short time till load ammeter indicates that the current has dropped. Then, move to "off" position.
2. Apply brakes.

NOTE: Trains will be handled smoothly if kept stretched by a light application of air brakes on the train; then gradually retard the throttle as in (1).

B. Emergency stop:

1. Apply brakes in emergency application.
2. Move throttle to the "off" position.

Releasing the deadman pedal will also stop the locomotive. This will automatically stop the train by cutting the power off the traction motors, dropping the engine to idle and making a service brake application. Under no circumstances is this to be regarded as normal procedure for stopping a train.

X. EMERGENCY FUEL CUT OFF VALVE

In case of fire, on or near the locomotive, or in event of an accident, the fuel supply must be shut off immediately. See page 315, for complete instructions.

XI. TO STOP AN ENGINE

A. Throw isolating switch to "off" position.

B. Open engine stop switch.

C. Open auxiliary generator switch.

D. Open fuel pump switch.

XII. TO CUT OUT TRACTION MOTORS

Stop the locomotive as per Section IX; then open the proper traction motor cut out switch. If it is desired to cut out only two motors supplied from one engine, open one of the traction motor cut out switches located in the electrical equipment cabinet and leave the other closed.

The power unit may then be put back on the line by closing the isolating switch on the engine control panel supplying power to the remaining two traction motors. These switches must not be operated while power is on.

IMPORTANT:

When a pair of traction motors have been taken out of service the load as indicated by the ammeter for the respective power unit must be restricted to one-half the current ratings listed under Section VII. If this is not adhered to, the two motors in operation will also be damaged. This does not mean that it is necessary to operate at half throttle to obtain half the load ratings.

XIII. TOWING LOCOMOTIVE

When a shutdown locomotive is to be moved by an outside source of power such as a switch engine, or is being hauled in a train, the following procedure should be followed:

A. Shut the engine down as per Section XI.

B. Open battery cut-out switch.

C. Place the handles of both brake valves in "running position, close the double heading cock and open the dead engine cock. The locomotive brakes will operate like those of a car in a train.

D. Open engine room and engineer's cab light switches.

XIV. PROCEDURE WHEN LEAVING CAB

1. Check that auxiliary generator switch, engine stop switch and fuel pump switch are open.
2. Open battery switch in electrical equipment cabinet.
3. Turn out lights.
4. Take precautions as outlined in description of cooling water system.
5. Apply hand brakes.
6. Remove reverse lever.
7. Turn key in control push button switch station to locked position and remove key.
8. Set locomotive brakes with independent brake valve and close cut out cock.

XV. PROCEDURE FOR MULTIPLE OPERATION

A. Couple the rear ends of the two locomotives together and make the following connections:

1. Train line jumper.
2. Actuating pipe.
3. Main reservoir lines.
4. Brake pipe line.
5. Applicating and release pipe.
6. Controlled emergency pipe.
7. Signal pipe.
8. Throttle pipe.

B. On controlling locomotive

1. Apply brake valve handles and check that double heading cock and double cut-out cocks are open.
2. Insert reverse lever.
3. Close battery switch.
4. Close control and stop switches.
5. Start engines.
6. Place isolating switch in "on" position.
7. Close auxiliary generator switch and power cut-out switch.

C. On locomotive to be controlled

1. Make full service reduction from automatic brake valve.
2. With automatic brake valve handle in lap position close double heading cock on brake valve.
3. Return automatic brake valve handle to running position and remove it.
4. Close double cut-out cock under independent brake valve and remove independent brake valve handle.
5. Put rotair valve handle in lap position.
6. Check that push button switches are open; remove reverse lever.
7. Check that controller is in "off" position.
8. Close battery switch and stop switch.
9. Start engine.
10. Place isolating switch in "on" position.
11. Close auxiliary generator switch and power cut-out switch.

D. The units are now ready to operate in multiple.

Procedure for a BLW unit doubleheading with a steam locomotive:
Watch ammeter readings and keep within load limits as tabulated on page 215. This precaution is necessary in order not to assume a disproportionate share of load as the steam locomotive slows down on grades.

XVI. PROCEDURE FOR CHANGING ENDS

1. Make full service reduction from automatic brake valve.
2. Place automatic brake valve handle in lap position; close double heading cock on brake valve.
3. Return automatic brake valve handle to running position and remove it. Place rotair valve in lap position.
4. Close double cut-out cock under independent brake valve and remove independent brake valve handle.
5. Remove reverse lever and key for locking control push button switch station.
6. Proceed to opposite end, apply brake valve handles, place independent brake valve in full application position and open double heading cock and double cut-out cock.
7. Return rotair valve to corresponding position.
8. Insert reverse lever and key for control push button switch station. Put reverse lever in "off" position and turn key to unlock push buttons. Make brake test.

XVII. TO CUT OUT A POWER UNIT ENROUTE

Stop engine as per Section XI. This may be done even while the other units are working under advanced throttle.

If trouble develops with a power unit it can be isolated as follows:

Throw the isolating switch on the engine control panel to the "off" position. This will open the traction motor circuit and reduce the engine speed to idling.

XVIII. TO START ENGINE AND PUT POWER UNIT BACK ON LINE

After correcting trouble, the engine can be started and put back into service as follows:

A. Start fuel pump.

B. Close engine shutdown switch on engine room control panel.

C. Start engine as per Section III, item C-4.

D. Close auxiliary generator switch in electrical equipment cabinet.

E. Put power unit back on line as follows:

Throw isolating switch on engine control panel to "on" position.

PRECAUTIONS TO BE OBSERVED

USE OF DEADMAN PEDAL

Release of the deadman pedal automatically stops the locomotive by (1) cutting off power from the traction motors, (2) dropping the engines to idle and (3) making a service brake application. Designed strictly as a safety device in event of incapacity of the engineer, this sudden power shut down can prove detrimental to the electrical equipment involved. Consequently, a deadman pedal stop is positively <u>not</u> to be regarded as normal practice.

RUNNING THROUGH WATER

Care must be taken not to allow the traction motors to come in contact with water unnecessarily. In case of unavoidable operation of the locomotive over water covered track, speed should be reduced. No attempt should be made to run through the water more than three inches in depth above top of rail.

OPERATING OVER CROSS-OVERS

The throttle should be reduced at about a car's length ahead of a cross-over to avoid excessive jar on gear teeth and to prevent pitting of commutators, which would be the result were the locomotive to be operated over cross-overs at full normal current.

HELPFUL HINTS FOR OPERATORS

IF ENGINE OVERSPEED STOP TRIPS

Reset manually. See page 302 for complete instructions.

INCIDENTAL REVERSING MOVEMENTS

The reverse lever should always be set in the direction of travel, as (1) in drifting backward against slack, or (2) live locomotive being moved by another locomotive. In many instances a neutral position would be sufficient, but since the lever must definitely be moved from its preceeding operating position it is wise to set in direction of travel.

IF LOCOMOTIVE UNITS UNCOUPLE

Set the hand brakes at once if the main reservoir line is broken, since the engines will drop down to idle and thus the compressors will not be able to produce enough air to maintain pressure. Close angle cocks as soon as possible.

IF ALARM SOUNDS

A. If no engine has stopped. Inspect indicator lights for blower stopped, ground, hot water, or steam generator stopped (if locomotive is equipped with steam generator).

   1. If blowers have stopped. Try replacing blower fuse. Shut engine down on affected unit if blowers cannot be started. Do not attempt normal operation. Other units in multiple can probably move train into the clear. If not, be governed by railroad operating rules governing limited operation with blower by-pass switch open.
   2. If a ground develops. The engine is isolated; try resetting ground relay. If ground was transient, ground relay will remain closed. If it trips again, limited operation is possible by opening ground by-pass switch. Be governed by railroad operating rules. Report to maintenance department as soon as possible.
   3. If hot water temperature switch has closed. The engine is isolated; see "Operating Difficulties and Causes" - Engine Overheats.
   4. If equipped with steam generator. If boiler shuts down; check fuses.

B. If an engine has stopped. Routine inspection as per the following may locate the trouble:

   1. Low lube oil pressure switch may have opened. This will cut down fuel oil supply and stop engine. Pressure must be restored to normal. See Section VIII, B.
   2. Engine shutdown switch may have tripped. This breaker type switch must be thrown to full "off" position before again closing it.
   3. Fuel pump switch may have tripped. Close as in 2, just preceeding.

NOTES

OPERATING DIFFICULTIES AND CAUSES

ENGINE FAILS TO TURN WHEN ATTEMPT IS MADE TO START

1. Battery switch open.
2. Fuel pump switch at control switch station in cab may be open.
3. Engine stop switch may be open.
4. Starting contactors may be stuck open.

ENGINE TURNS BUT WILL NOT FIRE OR IT WILL NOT CONTINUE TO RUN AFTER RELEASING THE START BUTTON

1. Fuel pump motor switch at engine room control panel not closed.
2. Fuel tank empty.
3. Emergency fuel shut off valve has been tripped.
4. Engine overspeed stop has been tripped. See 302.
5. Clogged fuel filter or strainer.
6. Fuel system not primed properly.
7. Fuel pump not functioning properly.
8. Insufficient lubricating oil pressure to keep the low pressure switch from operating.
9. Engine shut down cylinder or magnet valve not operating properly.
10. Insufficient oil supply in the governor.

ENGINE RUNS BUT THE SPEED WILL NOT INCREASE WITH THE THROTTLE SETTING

1. Isolating switch not in the "on" position.
2. Throttle magnet valve not operating properly.
3. Starting contactor stuck in the closed position.
4. Insufficient control air pressure; consult gauge in nose compartment of locomotive.
5. Faulty governor.
6. Power cut out switch may be in open position.
7. Control switch button fuse blown.
8. Hot water switch closed.

ENGINE OVERHEATS

1. Insufficient water supply.
2. Automatic shutter control not operating properly. (Move switches to the open position or operate manually and report to maintenance.)

3. Engine overloaded.
4. Radiator fan fuses may be blown.
5. Cooling system circulating pump not functioning.

ENGINE STOPS

1. Fuel tank empty.
2. Low lubricating oil pressure, causing engine shutdown valve and cylinder to operate. See Section 3.
3. Emergency fuel shut-off valve has been tripped.
4. Engine overspeed stop has tripped. See page 302.
5. Engine stop switch has been opened.
6. Failure in fuel supply pump. See page 316.
7. Fuel pump switch (breaker type) tripped.
8. Clogged fuel filter or strainer.
9. Hot oil switch open.

LOCOMOTIVE DOES NOT MOVE WHEN THROTTLE IS OPENED

1. Reverse lever in "off" position.
2. Power cut-out switches open.
3. Control fuse at control switch station may be blown.
4. Isolating switches in "off" position.
5. Power knockout switch fails to close.
6. Traction motor cut out switch open.
7. Auxiliary generator switch (breaker type) has opened.

TO OPERATE "B" UNIT INDEPENDENTLY

Follow the same general procedure as for operating "A" units. Lights are turned on by switches located at front and rear doors.

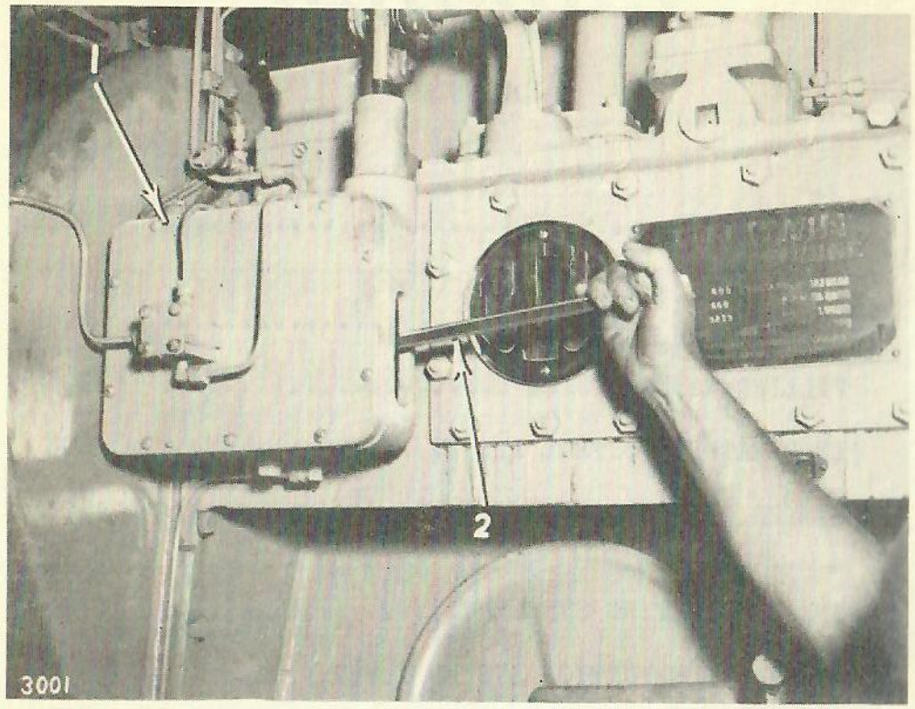
NOTES

N O T E S

D I E S E L E N G I N E

CONTENTS

	Page
OVERSPEED STOP	302
ENGINE COOLING SYSTEM	303
FILLING WATER SYSTEM	303
TEMPERATURE CONTROL	303
WINTER OPERATION	306
ENGINE LUBRICATING SYSTEM	308
FILLING LUBRICATION SYSTEM	308
LOW OIL PRESSURE SHUTDOWN	308
LUBRICATING OIL PRESSURE	309
HOT OIL SWITCH	310
ENGINE FUEL SYSTEM	315
FILLING FUEL TANK	315
EMERGENCY FUEL CUT OFF	315
FUEL FILTERS	315
SHUTDOWN VALVE	316
LOSS IN FUEL PRESSURE	316



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OVERSPEED STOP
Figure 1

1. Overspeed Stop
2. Fuel Pump Priming and Overspeed Stop Reset Bar (Pull Down to Reset)

D I E S E L E N G I N E

A complete description of the Diesel engine and its parts will be found in the Engine Maintenance Manual.

OVERSPEED STOP

If the engine speed should exceed the predetermined setting of the overspeed stop, the fuel injection pump control shaft will be moved to the "No Fuel" position, thus shutting down the engine. To reset the overspeed stop, insert a one-half inch diameter bar or a screwdriver into the housing to engage the tripping lever. Pry downward until the mechanism is reengaged.

Repeated engine shutdown by the overspeed stop requires investigation of the cause. Maintenance Department should be notified as soon as possible.

E N G I N E C O O L I N G S Y S T E M

The engine cooling system consists of an engine driven centrifugal pump, radiator section, cooling fan and automatically controlled shutters.

FILLING WATER SYSTEM

The cooling system can be filled either thru the filler cap located on the cab roof over the radiator section or thru the filler lines located on each side of the locomotive. Use the side filler lines whenever possible to prevent air pockets from forming in the system.

Water should normally be added to the system, when engine is not in operation and preferably when engine is cold. If necessary to add water while engine is warm (above 120° F.), water should either be heated or added very slowly. The engine system water supply can be replenished in an emergency from the steam generator water supply.

A source of water to be used as a coolant should be distilled or chemically treated. For complete information see Engine Manual.

TEMPERATURE CONTROL

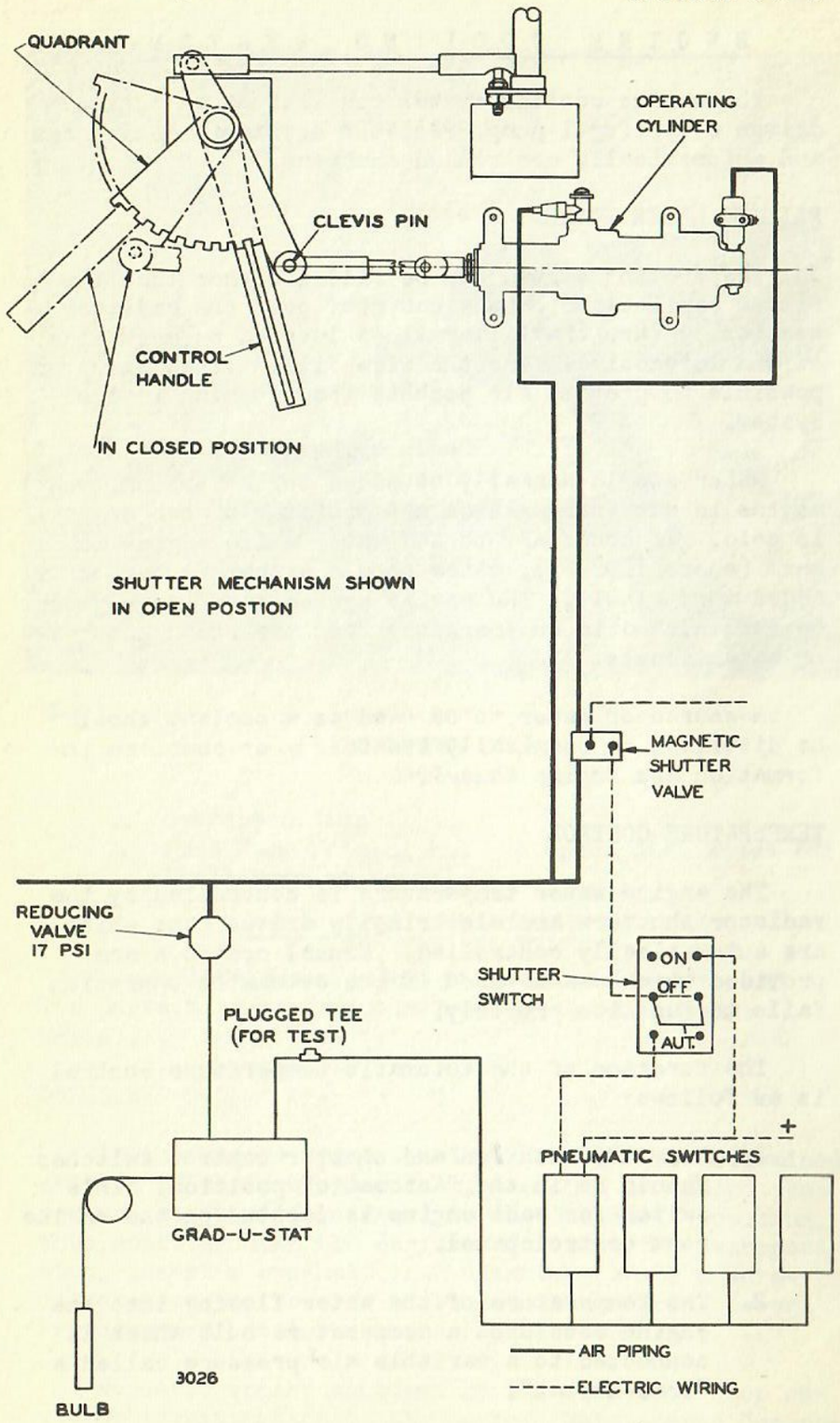
The engine water temperature is controlled by the radiator shutters and electrically driven fans which are automatically controlled. Manual controls are provided which can be used if the automatic operation fails to function properly.

The function of the automatic temperature control is as follows:

1. Normally both fan and shutter control switches should be in the "Automatic" position. This switch for each engine is located on the engine room control panel.

2. The temperature of the water flowing into the engine acts upon a temperature bulb which is connected to a variable air pressure called a "Grad-u-stat".

3. The varying air pressure determined by the



SHUTTER OPERATION FOR TEMPERATURE CONTROL
Figure 2

"Grad-u-stat" acts on an operating cylinder which operates the shutters. These air pressure changes also actuate pneumatic electric switches which control the speed of the fan motors.

4. The cycle of automatic operation is as follows:

INCREASING WATER TEMPERATURE

Operation	Inlet Water Temperature °F.
Shutters open full and fan motors operate at slow speed	153°
Fans operate at intermediate speed	155°
Fans operate at medium speed	157°
Fans operate at maximum speed	158°

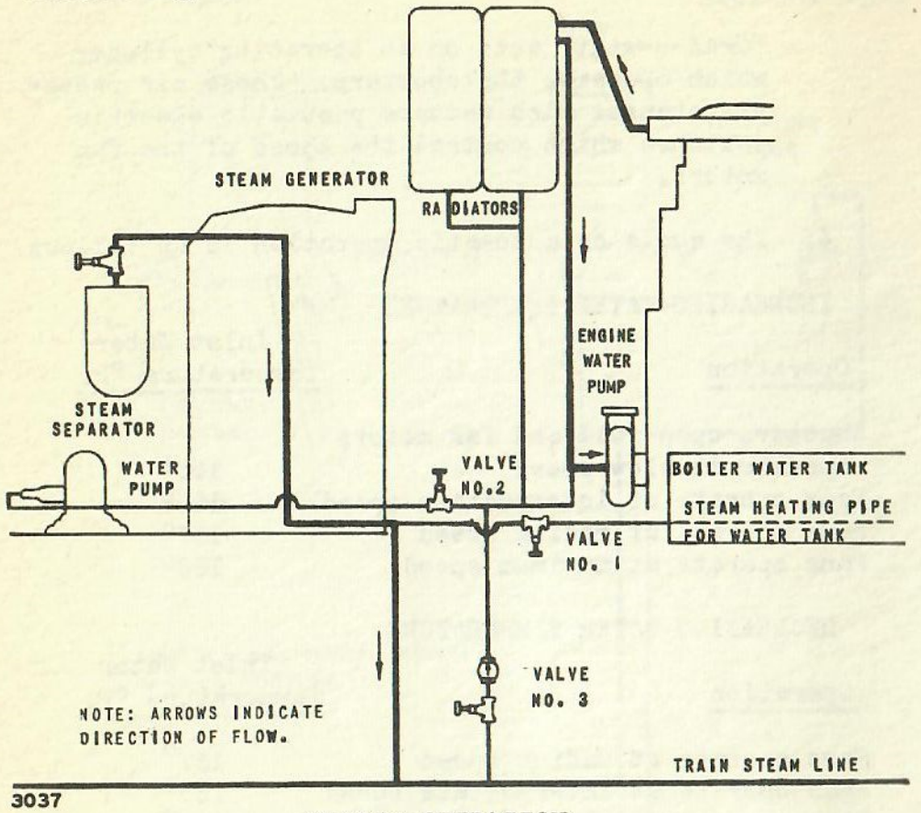
DECREASING WATER TEMPERATURE

Operation	Inlet Water Temperature °F.
Fans operate at medium speed	157°
Fans operate at intermediate speed	155°
Fans operate at slow speed	153°
Fans stop. Shutters close	151°

When the automatic temperature control does not function properly, the temperature control mechanism may be manually controlled as follows:

By putting the water temperature control switch, located on the engine room control panel in the "on" position the shutters will open full and the fans will run at intermediate speed. Should the water temperature drop too low in this position, it can be increased by partially closing the shutters. This can be accomplished by disengaging the shutter control handle from the quadrant and moving it to the desired shutter position.

A hot water control switch set at 200° will act on the engine shutdown valve to idle the engine should the engine cooling water temperature become excessive. See Fig. 2.

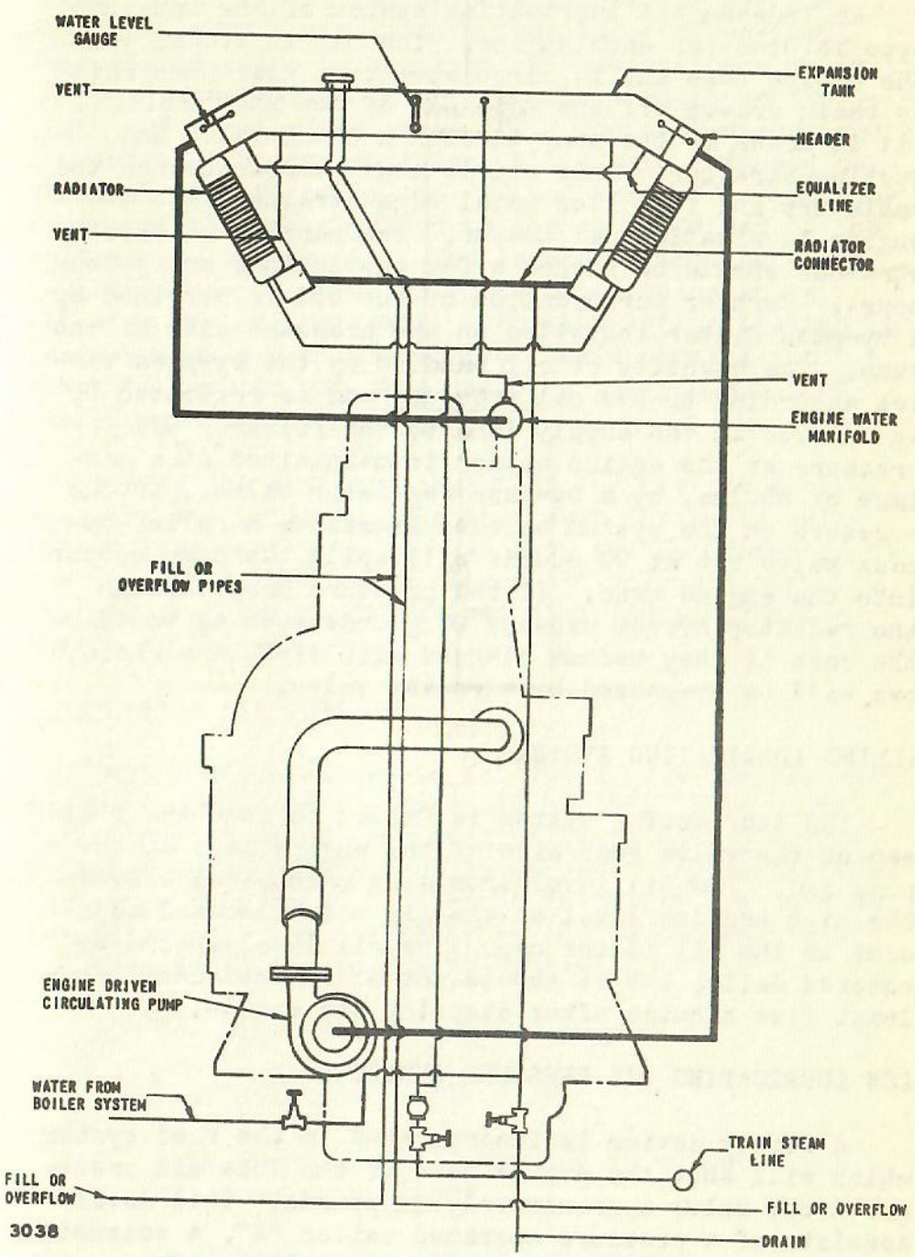


WINTER OPERATION
Figure 3

WINTER OPERATION

When the locomotive is operating in freezing weather, it will be necessary to supply steam from the boiler to the heating pipe in the boiler water supply tank to prevent the water from freezing. Valve No. 1 controls the supply of steam to the heating pipe. It should be opened just enough to keep the water temperature above freezing.

If the locomotive is to be left outside during freezing weather, precautions must be taken against freezing the engine cooling water and boiler water systems. Steam should be supplied to the locomotive steam line by an outside source. By opening valve No. 3 shown on Fig. 3, this steam will be admitted to the engine water system. Opening valve No. 1 will admit steam to the heating pipe in the boiler water tank. It will be necessary to drain the steam generator coils, steam separator and water treatment tank to prevent freezing. Instructions for draining will be found in the steam generator section.



ENGINE COOLING SYSTEM DIAGRAM
Figure 4

ENGINE LUBRICATING SYSTEM

An independent lubricating system of the wet sump type is used for each engine. The oil is stored in the engine base and is circulated by a gear pump which is chain driven off the free end of the crankshaft. Oil is drawn by the pump through a check valve and suction strainer. This oil is then pumped through the radiators and full flow metal edge strainer into the engine lubricating oil header. The handles on this strainer should be turned a few revolutions every four hours. Further purification of the oil is obtained by a by-pass filter installed on the pressure side of the pump. The quantity of oil handled by the by-pass varies according to the oil pressure and is regulated by an orifice in the supply line to the filter. Oil pressure at the engine header is maintained at a maximum of 65 lbs. by a by-pass regulator valve. If the pressure on the system becomes excessive a relief by-pass valve set at 90 pounds will spill the pump output into the engine base. If the pressure drop through the radiator system exceeds 25 pounds such as would be the case if they become plugged with dirt, the radiators will be by-passed by a relief valve.

FILLING LUBRICATING SYSTEM

The lubricating system is filled through the filler cap on the valve gear side of the engine base at the pump end. The oil level should be maintained between the high and low level on the dip stick located adjacent to the oil filter cap. The oil level should be checked daily, but it should not be checked until at least five minutes after stopping the engine.

LOW LUBRICATING OIL PRESSURE SHUTDOWN

A safety device is incorporated in the fuel system which will shut the engine down if the lube oil pressure drops below approximately 20 pounds. This device consists of a pressure operated switch "A", a solenoid operated valve "B" and a shutdown unit "C". The switch "A" is operated by the pressure in the lube oil header. During normal operation it is held in the closed position permitting the current to energize the solenoid "D" which then keeps the valves "E" open and "F" closed. When the valve "E" is open the supply line "G" is in direct communication with the shutdown unit "C", through the line "H". The piston of the shutdown unit

is then forced outward by the fuel pressure moving the lever "I" to a position which will release the fuel injection pump control shaft from the stop position. When the pressure in the lube oil header drops below 15 pounds the switch "A" breaks the circuit to the solenoid "D" closing the valve "F". The fuel under pressure in the shutdown cylinder "C" is then released to the fuel tank through line "H" and valve "F" resulting in the piston being pushed to the opposite end of the cylinder by the spring. The lever "I" then turns the injection pump control shaft to the stop position shutting the engine down. A torsion spring located at the governor end of the control shaft permits the shaft to turn to the stop position independently of the governor.

During the starting operation, before the lube oil pressure has built up, the shut down device is maintained inoperative by an auxiliary switch connected to the starter button which closes the solenoid circuit. The pressure switch "A" should close before starter button is released.

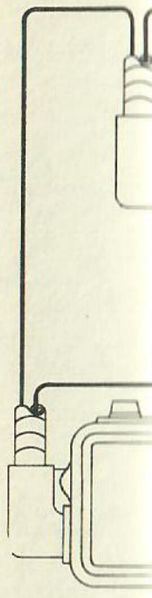
LUBRICATING OIL PRESSURE

Engine oil pressure is regulated by a by-pass valve at the entrance to the lube oil header. This valve is set for 65 pounds and will maintain this pressure at rated speed unless trouble arises. Any perceptible deviation from this pressure at rated speed should be investigated. Low oil pressure may be the result of one or more of the following causes:

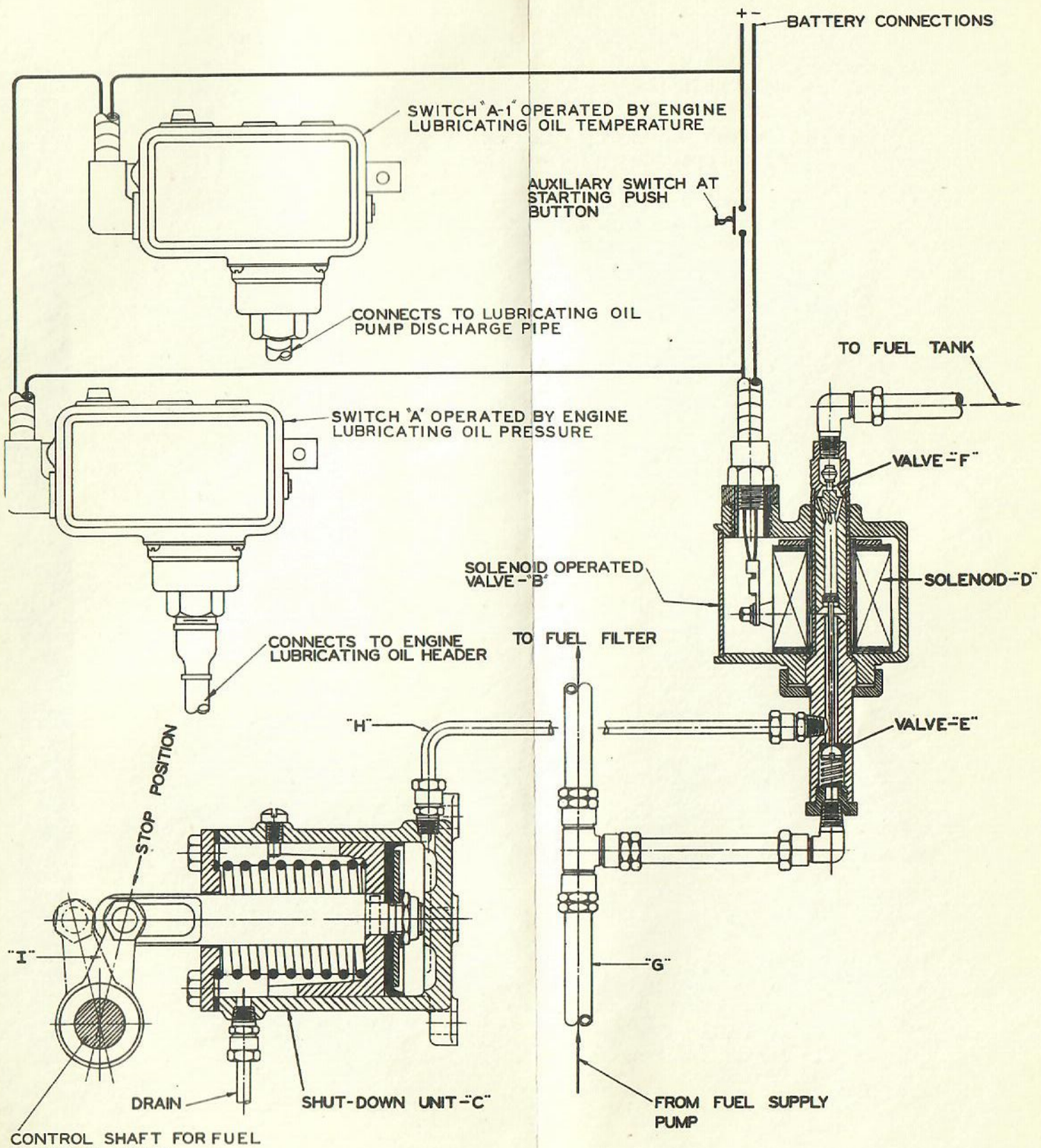
1. Low oil level, check and restore.
2. Fuel dilution, replace oil.
3. Leak in pressure system due to broken lines or loose connections.
4. Regulator valve, check and reset.
5. Faulty oil pressure pump.
6. Clogged suction strainer.
7. Clogged metal edge pressure filter.

HOT OIL SWITCH

Designed to open or close with fluctuations in lubricating oil temperature, this switch is usually set to open at approximately 180° F. It is connected in series with the pressure switch on Figure 5, and functions in like manner with it, to operate the shutdown device.



Page 311



LOW LUBRICATING OIL SHUT DOWN DEVICE
Figure 5

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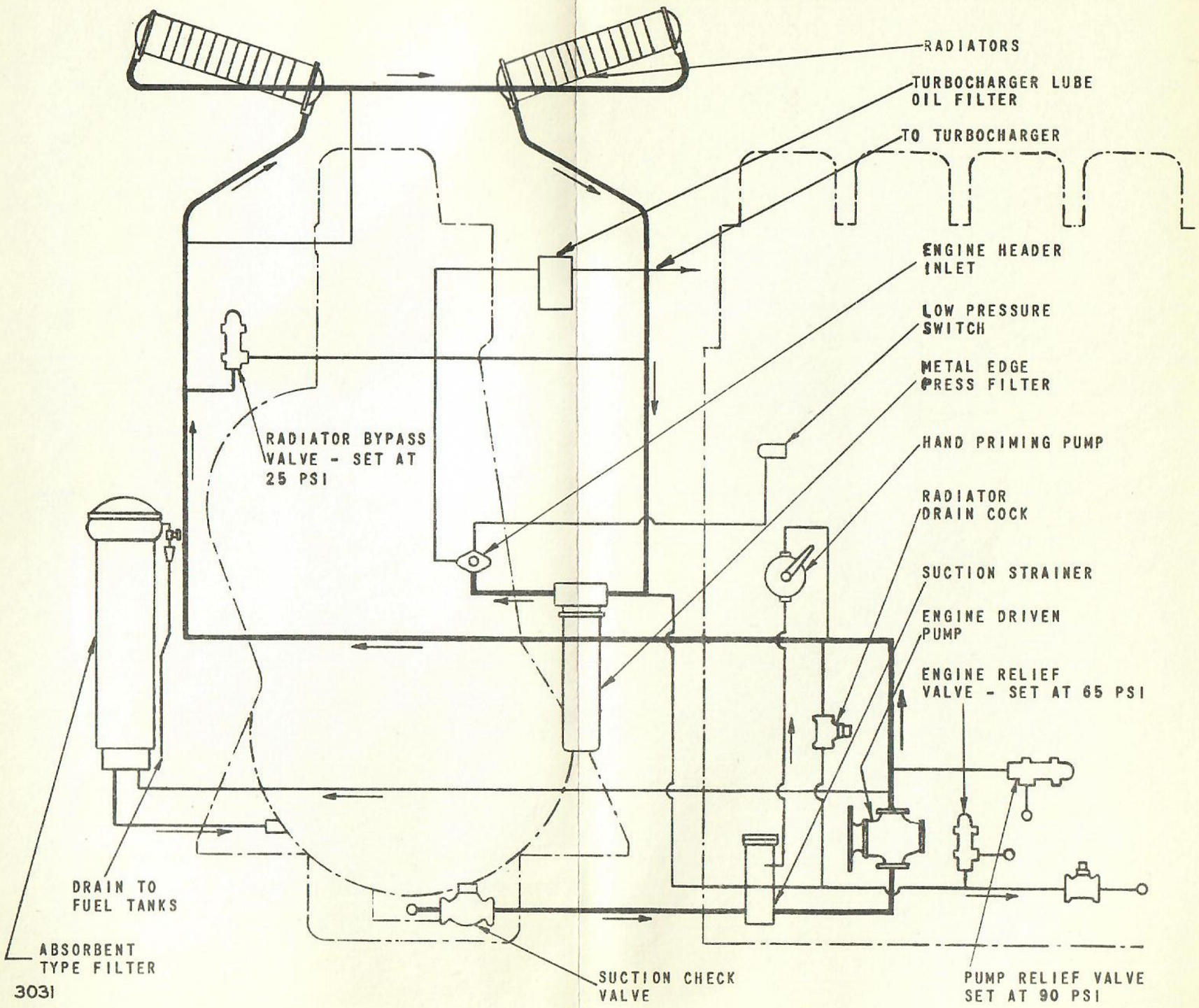


ENGINE LUBRICATING OIL SYSTEM DIAGRAM
Figure 6

ENGINE FUEL SYSTEM

Fuel is supplied to the engine by an electrically driven pump operating on storage battery current. This pump draws fuel from the supply tank through a suction strainer and forces it through a filter system to the fuel header supplying the injection pumps. A by-pass valve located at the end of the header regulates the fuel supply pressure to the injection pumps. The excess fuel from this valve is returned to the supply tank. Individual injection pumps are located adjacent to each cylinder with high pressure lines to the injection nozzle mounted in the center of the cylinder head. The injection nozzle is a multi-orifice type and sprays a symmetrical pattern into the combustion chamber.

FILLING FUEL TANK

The fuel tank is filled from either side of the locomotive. A gauge is located near the fill connection indicating the level of fluid in the tank.

EMERGENCY FUEL CUT OFF

An emergency fuel cut off valve is provided in the main suction line to the electrically driven fuel pumps for shutting off the fuel supply in case of fire. This valve must be reset manually whenever it is used to stop the supply of fuel to the engine. It is located on the top of the fuel tank on the right hand side under the skirt of the locomotive on both "A" and "B" units. It can be closed by pulling the pull ring located in the cab of "A" units on the side wall to the right of the engineer's position, or by a pull ring on the right side of each unit near the cut off valve on the fuel tank. Fuel must be cut off for each unit individually since the fuel supply lines are not interconnected.

FUEL FILTERS

The fuel pump is protected by an absorbent type fuel filter placed on the suction side of the pump. **This filter should be replaced periodically.**

The fuel injection pumps are protected by a double unit sintered bronze type filter. These filter elements should be **cleaned periodically.**

SHUTDOWN VALVE

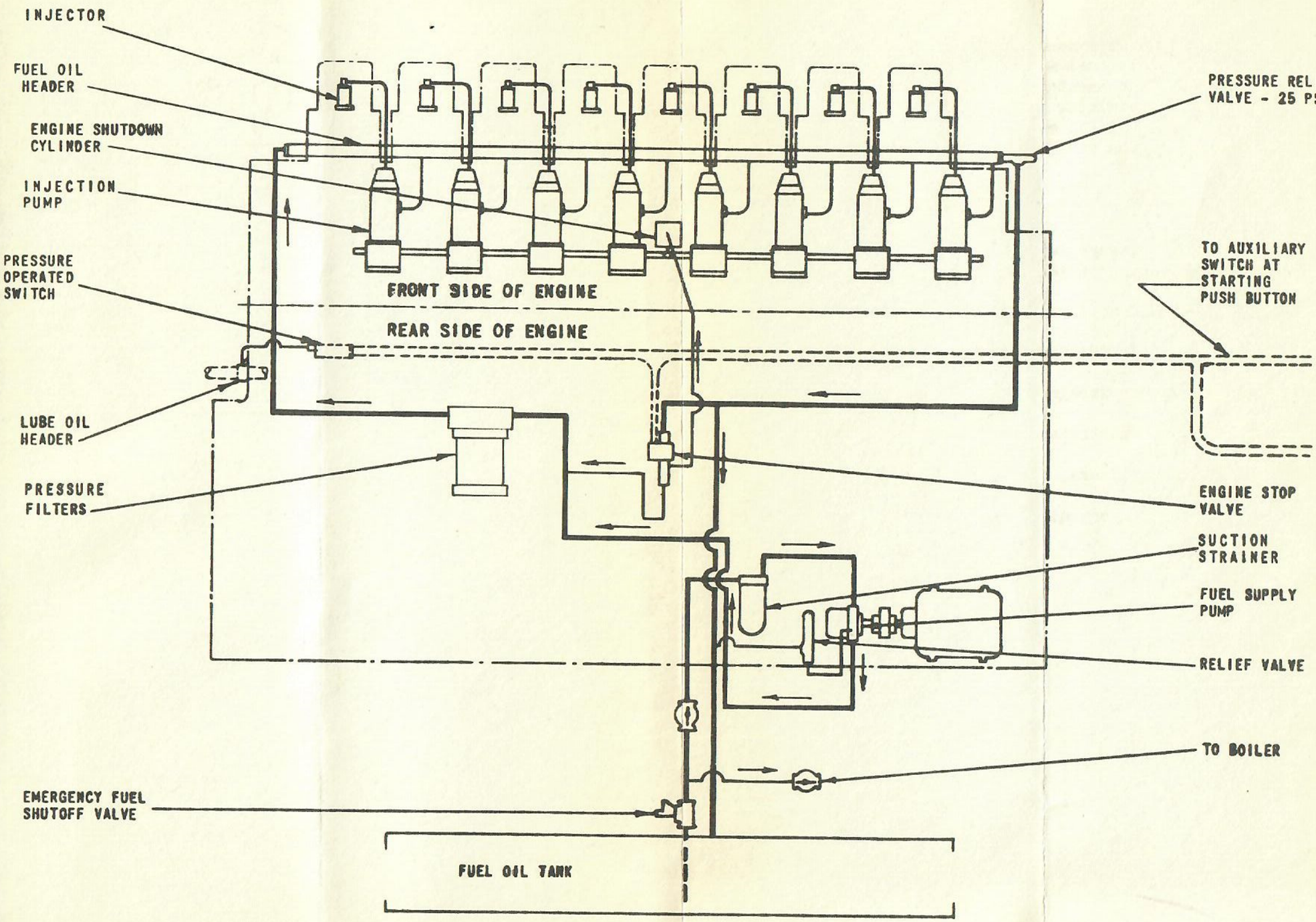
This engine stop valve must be energized electrically in order to supply fuel to the engine. Various safety devices may be connected to it for cutting off the fuel if trouble develops. The valve consists of solenoid "D" and the related valves shown on Figure 5, page 311. Its operation and functions are described on pages 308 - 309.

LOSS IN FUEL PRESSURE

A loss in fuel pressure may be the result of one or more of the following causes:

1. Fuel pump failure.
2. Fuel pump motor failure.
3. Leak in suction strainer.
4. Plugged suction strainer.
5. Plugged fuel filters.
6. Pressure regulator valve stuck open.

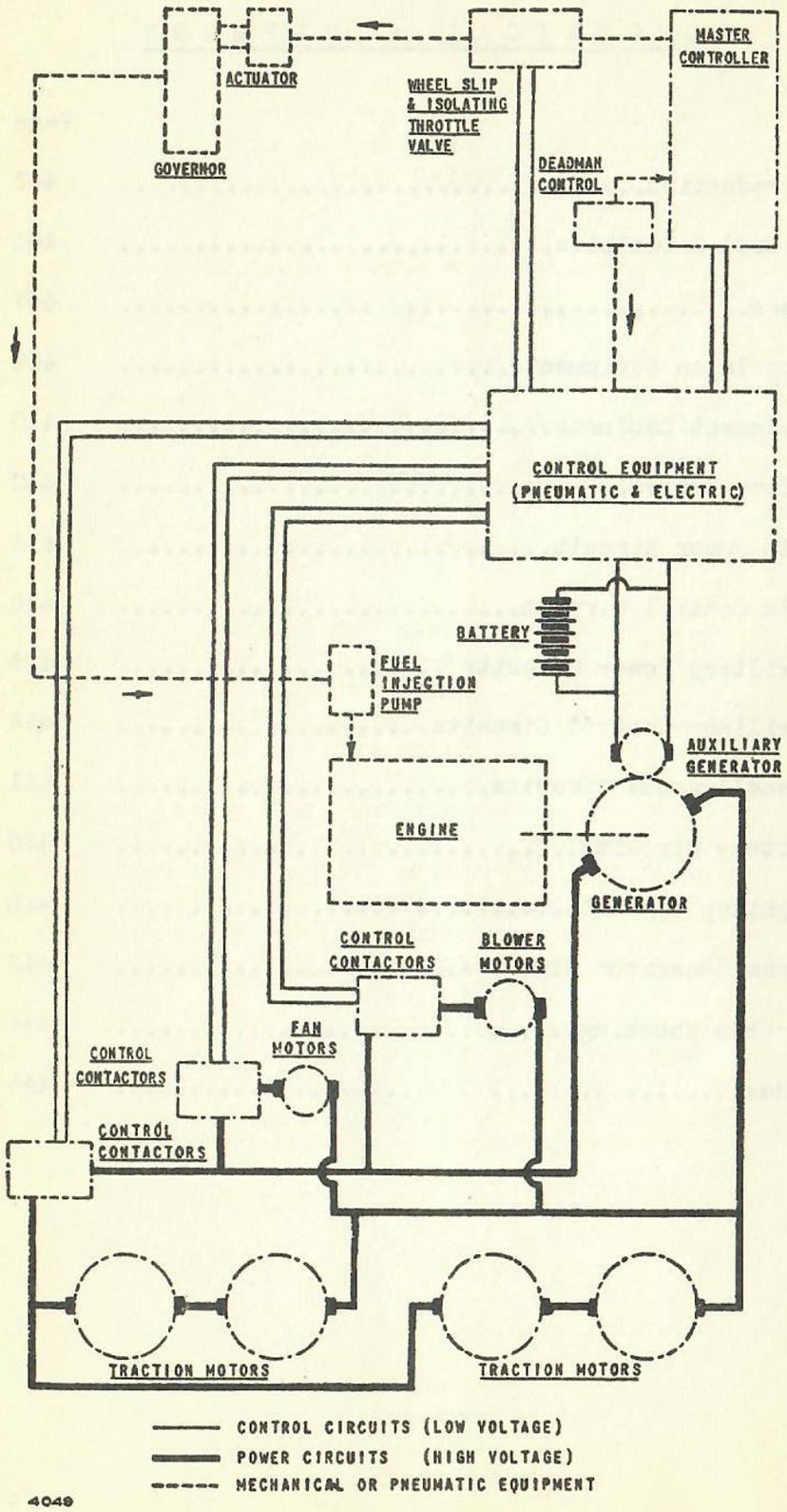
Page 317



ENGINE FUEL OIL SYSTEM DIAGRAM
Figure 7

E L E C T R I C A L E Q U I P M E N T

	Page
Introduction	403
General Principles	404
Fuses	407
Propulsion Equipment	409
Equipment Cabinets	410
Safety Notice	410
Main Power Circuit	415
Main Control Circuit	418
Auxiliary Power Circuits	424
Auxiliary Control Circuits	428
Miscellaneous Circuits	431
Battery Circuits	435
Lighting Circuits	440
Steam Generator Circuits	442
Trouble Shooting	444
Index	446



CONTROL SYSTEM DIAGRAM
Figure 1

INTRODUCTION

This section describes the function and operation of the various pieces of electrical equipment and their relationships in the various circuits. The electrical equipment of the locomotive consists of the following main elements.

a. Main Generator - driven by a Diesel engine.

b. Traction Motors - to transmit the power to the driving axles.

c. Power Control Equipment

d. Auxiliary Equipment and Controls

e. Miscellaneous Lights, Heaters and Steam Generator

The Control System Diagram in Fig. 1 shows the basic relationship of the principal electrical equipment, together with a schematic layout of the related pneumatic control lines. The Master Controller in the upper right corner functions (a) pneumatically through the governor and fuel injection pump to control the engine speed and power (via the dotted line), and (b) electrically through the control circuits to the contactors in each of the three principal power circuits, namely those to the traction motors, fan motors, and blower motors. (See legend at bottom of Fig. 1 to identify power and control circuits). The engine - driven generator supplies the power circuits, while the auxiliary generator charges the battery and furnishes a regulated low voltage power supply to the control circuits. The battery is shown in normal operating connection. Special starting circuits from the battery are explained later. Many details of the circuits are purposely omitted to facilitate understanding.

Each power unit consists of one generator, four traction motors and certain auxiliary equipment, all of which are electrically independent of any other power units which may be connected in multiple, except for certain low voltage control circuits. Control of routine operation is centered in the cab, except for starting buttons and similar incidental controls at the engine room control panel.

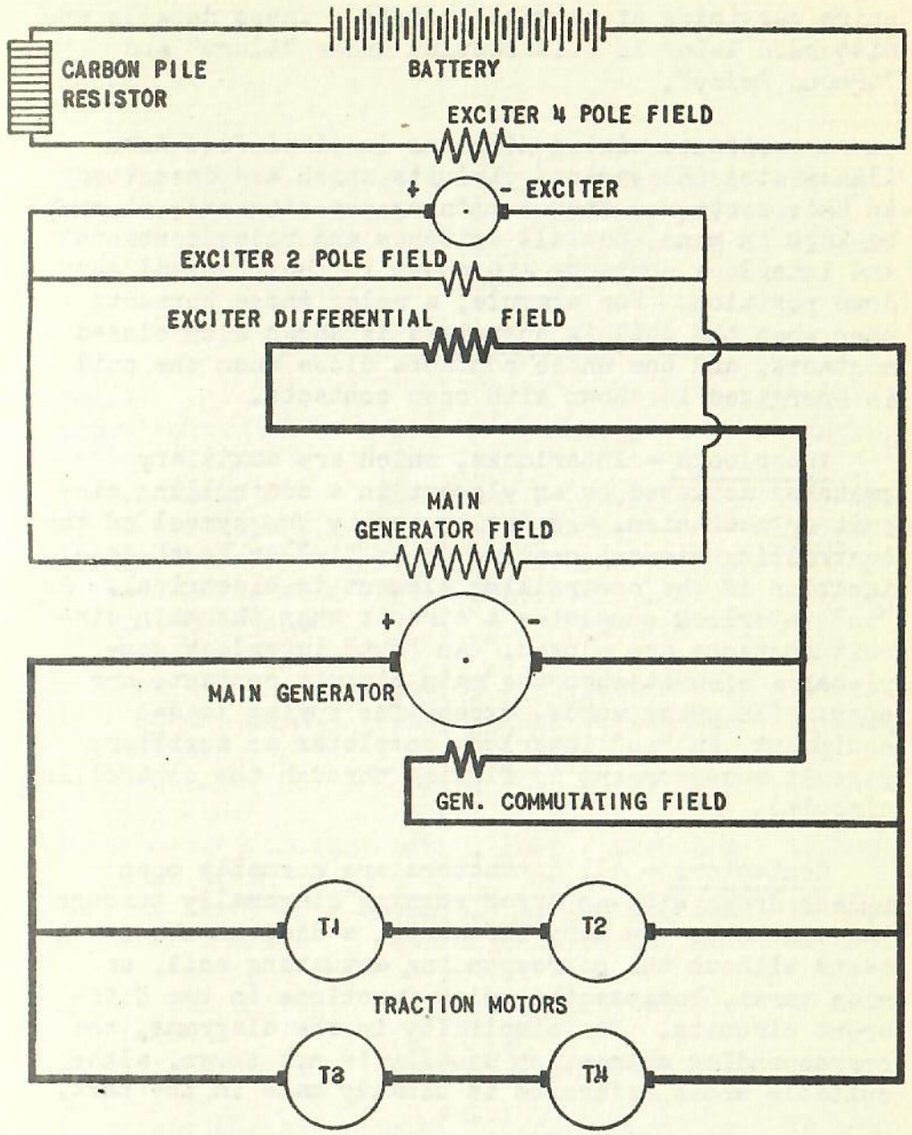
GENERAL PRINCIPLES

OF OPERATION

Each Diesel engine drives a generator which in turn powers the traction motors over various heavy duty high voltage circuits. A simplified schematic diagram of these connections is shown in Fig. 2. In starting, a high tractive effort and torque are necessary. The motor torque is proportional to the amperage, therefore a high current is required. Since there is no counter electro-motive force at stand still, and the motor's internal resistance is low, the current is high at low generator voltage and low generator speed. As the locomotive speed increases, the combined motor resistance and counter electro-motive force increases, and the generator voltage must be increased by increasing its speed, if high current is to be maintained. The speed of the engine-generator is pneumatically controlled by the throttle lever and governor. The amperage drops rapidly after the initial acceleration. The voltage increases to a maximum of about 850 volts as the generator speeds up. The exciter fields are so arranged that, at any engine speed, the maximum power input to (or output from) the generator is nearly constant. Under such conditions, the product of tractive effort x speed is constant for all speeds, and the product of generator voltage x amperes is constant for all amperages.

A low voltage circuit, 75 volts, is provided for as much of the auxiliary equipment and control apparatus as can possibly be removed from the high voltage circuits. This circuit is supplied by an auxiliary generator which also charges a battery for supplying the circuit when the power unit is not running.

Controls - Controls fall into two main classes, manual and automatic. In general, the manual controls are those required in starting a power unit, operating the locomotive, and emergency operation, isolation, or shutdown of portions of the locomotive while continuing operation with the remaining equipment. Automatic controls are protective or interlocking in nature or relieve the crew of incidental operating details necessary for efficient operating such as (a) field shunting of the traction, blower, and fan motors, or (b) the Carbonstat regulation of the exciter field for smooth acceleration. Some of the protective devices



4003

SIMPLIFIED SCHEMATIC WIRING DIAGRAM
Figure 2

function regularly in normal operation, while others function only when abnormal conditions arise. In many instances the proper attention to gauge readings, such as those for lube oil pressure and cooling water temperature, will reveal the trouble in advance, but should the crew fail to detect such conditions, the protective devices will function. An alarm system warns the crew of abnormal conditions. Some abnormal conditions may be rectified enroute, while others re-

quire servicing at terminal points. These details are discussed later in this section under "Alarm" and "Ground Relay".

A series of wiring diagrams in simplified form illustrates the various circuits which are described in this section. When examining the diagrams, it must be kept in mind that all switches and relay contacts and interlock contacts are shown in their normal shut down position. For example, a relay whose contacts open when the coil is energized is shown with closed contacts, and one whose contacts close when the coil is energized is shown with open contacts.

Interlocks - Interlocks, which are auxiliary switches actuated by an element in a controlling circuit or mechanism, are designated by the symbol of the controlling element coupled to an "in" or "out" designation if the controlling element is electrical. An "in" interlock completes a circuit when the main circuit contacts are closed. An "out" interlock completes a circuit when the main circuit contacts are open. (In other words, except for spring loaded equipment, an "in" interlock completes an auxiliary circuit when current is flowing through the controlling circuit).

Contactors - All contactors are normally open unless drawn with an arrow running diagonally through the contacts. In many instances, a diagram shows contacts without the corresponding actuating coil, or vice versa, because the relay functions in two different circuits. For simplicity in the diagrams, the corresponding connection usually is not shown, altho suitable cross reference is usually made in the text.

Electro-Pneumatic Valves - An electro-pneumatic valve consists of an electro-magnetic coil which actuates valves in the air lines. The coils are part of the electrical circuits and are shown in the wiring diagrams, but reference must be made to the Air Piping Diagram in Section 6, for the pneumatic portion of such equipment as, for example, the Compressor Valve, Throttle Valve, Sander Valves, Overspeed Valve, Power Switches and Reverser.

FUSES

FUSES

There are a total of 17 fuses on each locomotive. The first three fuses in the following table are in high voltage circuits. Observe safety precautions before replacing them. See Trouble Shooting at end of this section.

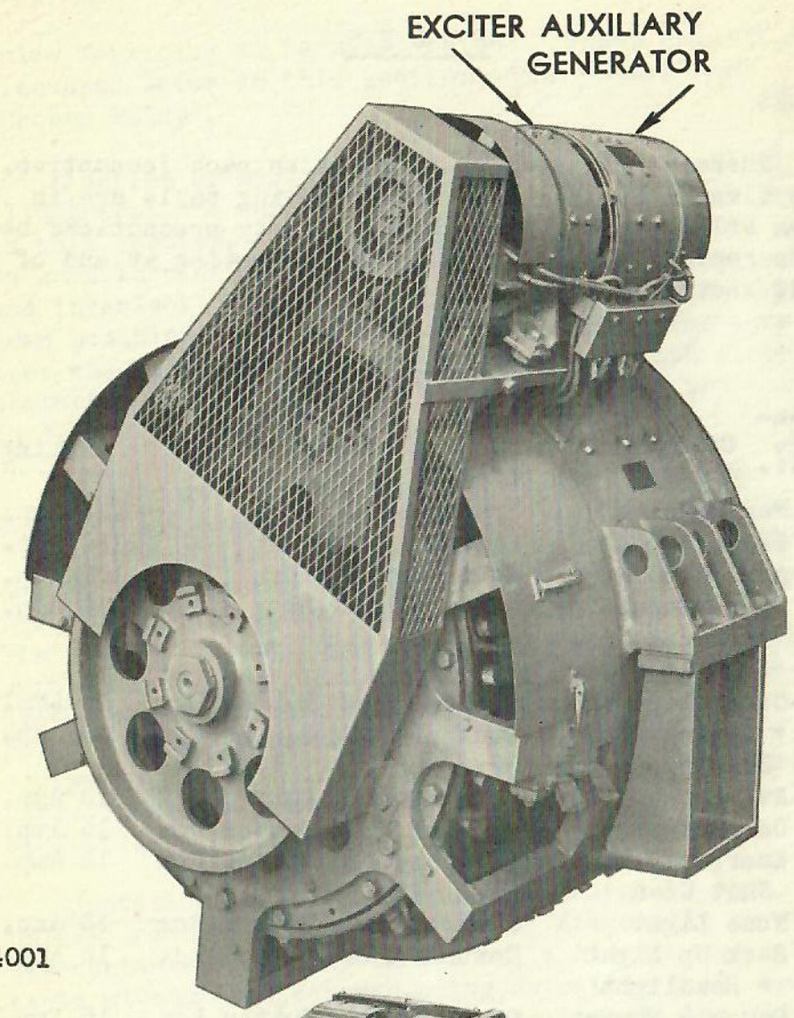
TABLE OF FUSES

Quantity	Circuit	Location	Rating
1	Fan Motor	Equipment Cabinet	175 Amp.
1	Blower Motor	Equipment Cabinet	110 Amp.
1	Aux. Generator	Equipment Cabinet	100 Amp.
4	Steam Generator (Control and Ignition)	Steam Generator	10 Amp.
1	Control	Control Push Button Box	15 Amp.
1	* Engine Room Lights	Control Push Button Box	15 Amp.
1	Attendant	Control Push Button Box	15 Amp.
1	Defroster	Control Push Button Box	15 Amp.
1	Emergency Engine Shut Down	Control Push Button Box	15 Amp.
1	Nose Light	Control Push Button Box	15 Amp.
1	Back Up Light * Headlight	Control Push Button Box	15 Amp.
1	Gauge & Number Lights	Control Push Button Box	15 Amp.
1	Classification Lights	Control Push Button Box	15 Amp.
1	Marker Lights	Control Push Button Box	15 Amp.

* These lights are fused as indicated, but are not controlled by the push button switch.

NOTE:

Do not replace a fuse with one of a higher amperage rating. If a fuse burns out immediately after replacement, do not replace it a second time until the trouble has been located and rectified or isolated from the circuit.



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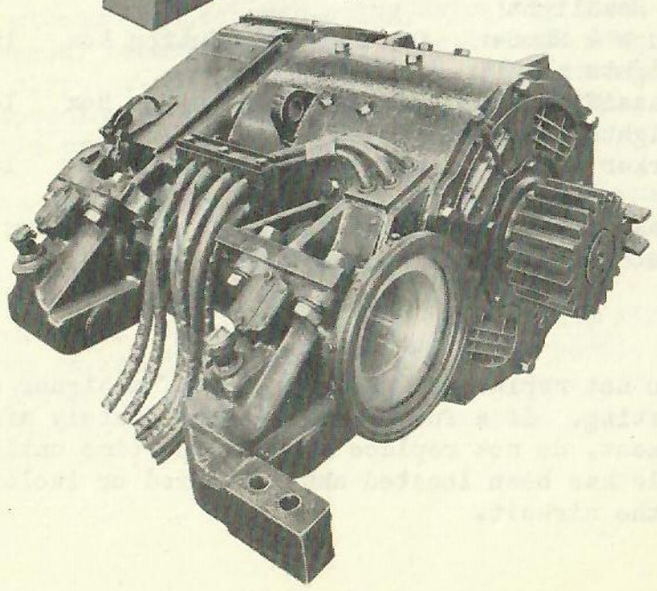


4002

MAIN GENERATOR AND TRACTION MOTOR
Figure 3

PROPULSION EQUIPMENT

MAIN GENERATOR

The main generator, shown in the top portion of Fig. 3 is a 12-pole d.c. self-ventilated single bearing generator directly connected to the Diesel engine by a coupling. It furnishes power over a wide range of speeds up to 625 r.p.m. and rotates in a counter-clockwise direction when viewed from the commutator end. It supplies power to the traction motors, radiator fan motors and blower motors.

AUXILIARY GENERATOR AND EXCITER

The auxiliary generator and exciter unit on the main generator frame (Fig. 3) is belt driven by the main generator.

The auxiliary generator is about 10 Kw. capacity. It charges the battery, supplies power to the fuel pump motors and defroster fans and energizes the control relays. It is regulated for constant voltage by a vibrating type voltage regulator. The auxiliary generator circuit is protected by a 100 ampere fuse which is mounted in the equipment cabinet.

The exciter supplies the main generator fields, and is specially wound to maintain power output as nearly constant as possible. To avoid overloading the engine, the strength of the main generator field must be varied so that the generator voltage is decreased as the current demand is increased. To do this the exciter has three seperate field windings, as follows:

(a) A 2-pole shunt field energized by exciter current.

(b) A 4-pole field energized by the auxiliary generator and regulated by a Carbonstat.

(c) A reversed (differential) field energized by main generator current.

The connections for these fields are shown in the Schematic Wiring Diagram in Fig. 2. When current from the main generator to the traction motors is high, the reversed field opposes the other exciter fields which

weakens the main generator fields and reduces the voltage and current supplied to the traction motors. The exciter is designed so that its inherent differential characteristics automatically decrease the field strength, and hence the voltage, of the generator as the current demand increases.

TRACTION MOTORS

The traction motor, shown in the lower portion of Fig. 3 is a direct-current, series-wound 6 pole motor mounted on, and geared directly to, each driving axle. Four motors are connected to each main generator as shown on the Simplified Schematic Wiring Diagram in Fig. 2. The motor connection remains the same for all running conditions. The field connections are reversed to reverse the direction of rotation of the motors. They are force-ventilated by separate motor driven blowers through ducts in the locomotive underframe feeding into openings in the top of the motors.

EQUIPMENT CABINETS

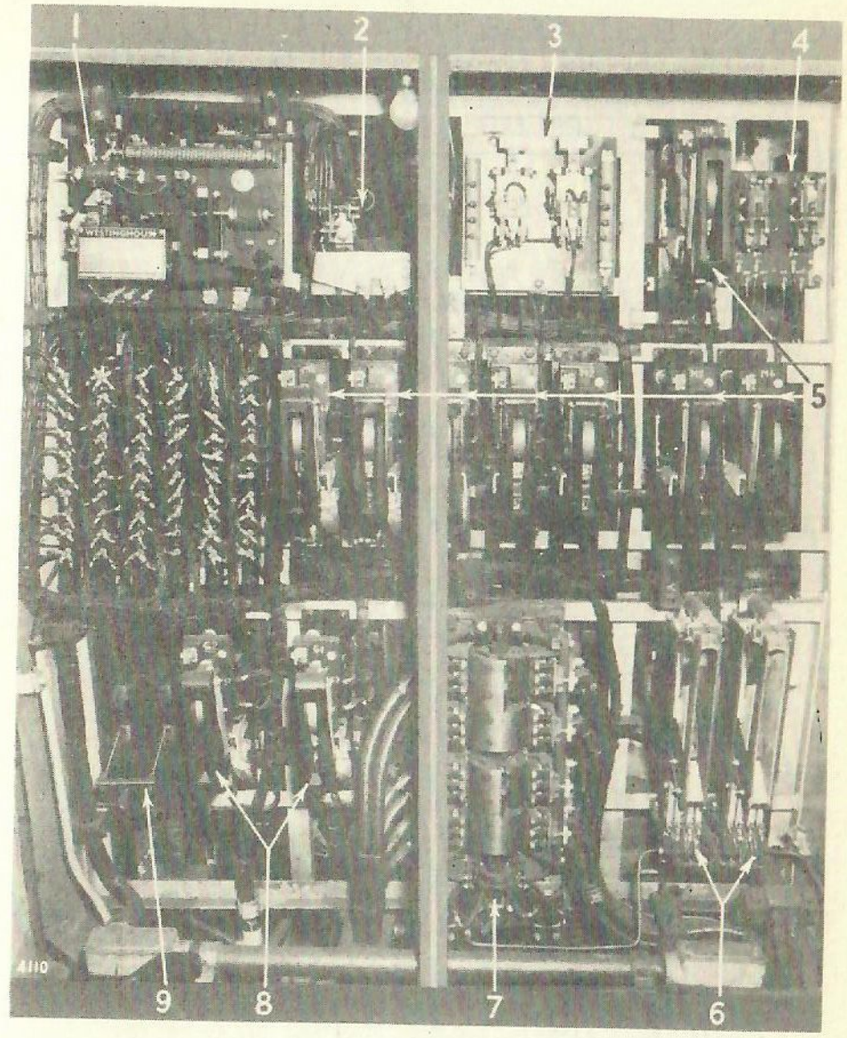
An electrical equipment cabinet, located behind the cab, contains most of the electrical equipment on the locomotive. Figure 4 shows the arrangement of the equipment on the front, opening into the cab. Figure 5 shows the arrangement on the sides, as seen from the aisle.

The engine control panel is mounted on the back of the cabinet. It contains two Engine Start Buttons, an Isolating Switch, Fuel Pump Switch, Fan and Shutter Switch, Engine Stop Switch and Gauges for Fuel Oil, Lube Oil Pressure and Water Temperature. See illustration Fig. 4, Section 2.

SAFETY NOTICE

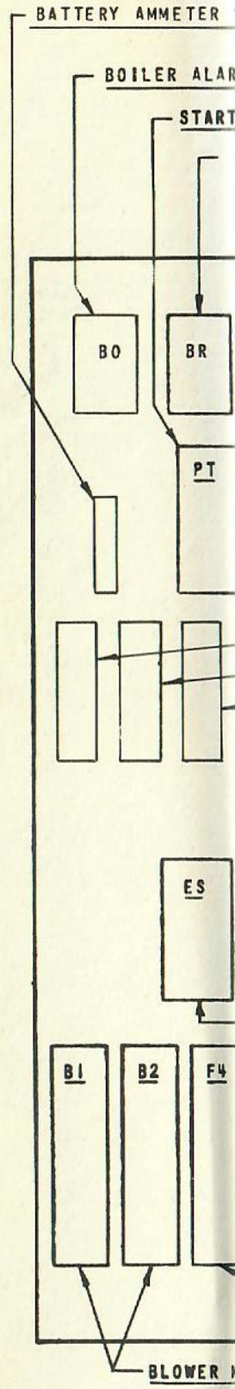
Voltages up to 1100 volts are used on much of the equipment in the cabinets. Cabinet doors should be kept closed as much as possible and no attempt should be made to gain access or make adjustments to the equipment by unqualified personnel.

The crew should also be familiar with all switches which should NOT be opened under load. Such instructions are given in the following text wherever applicable. Disregard of such instruction may cause arcing which may damage equipment or cause personal injury.



ELECTRICAL EQUIPMENT CABINET-FRONT VIEW
Figure 4

1. Voltage Regulator
2. Reverse Current Relay
3. Field Shunt Relay
4. Wheel Slip Relay
5. Field Shunt Contactor
6. Pneumatic Power Switch
7. Reverser
8. Starting Contactors
9. Battery Switch


BATTERY AMMETER
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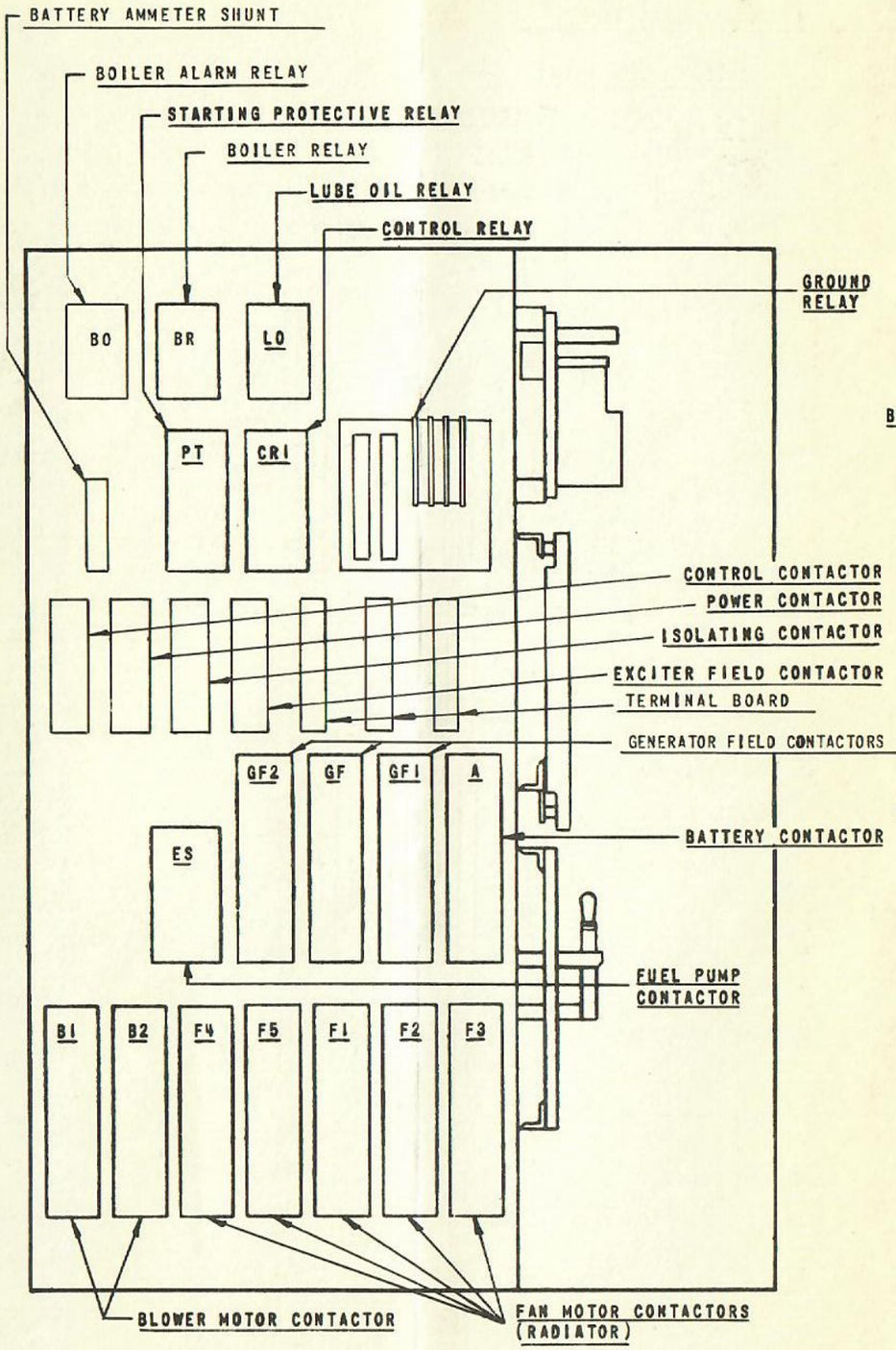
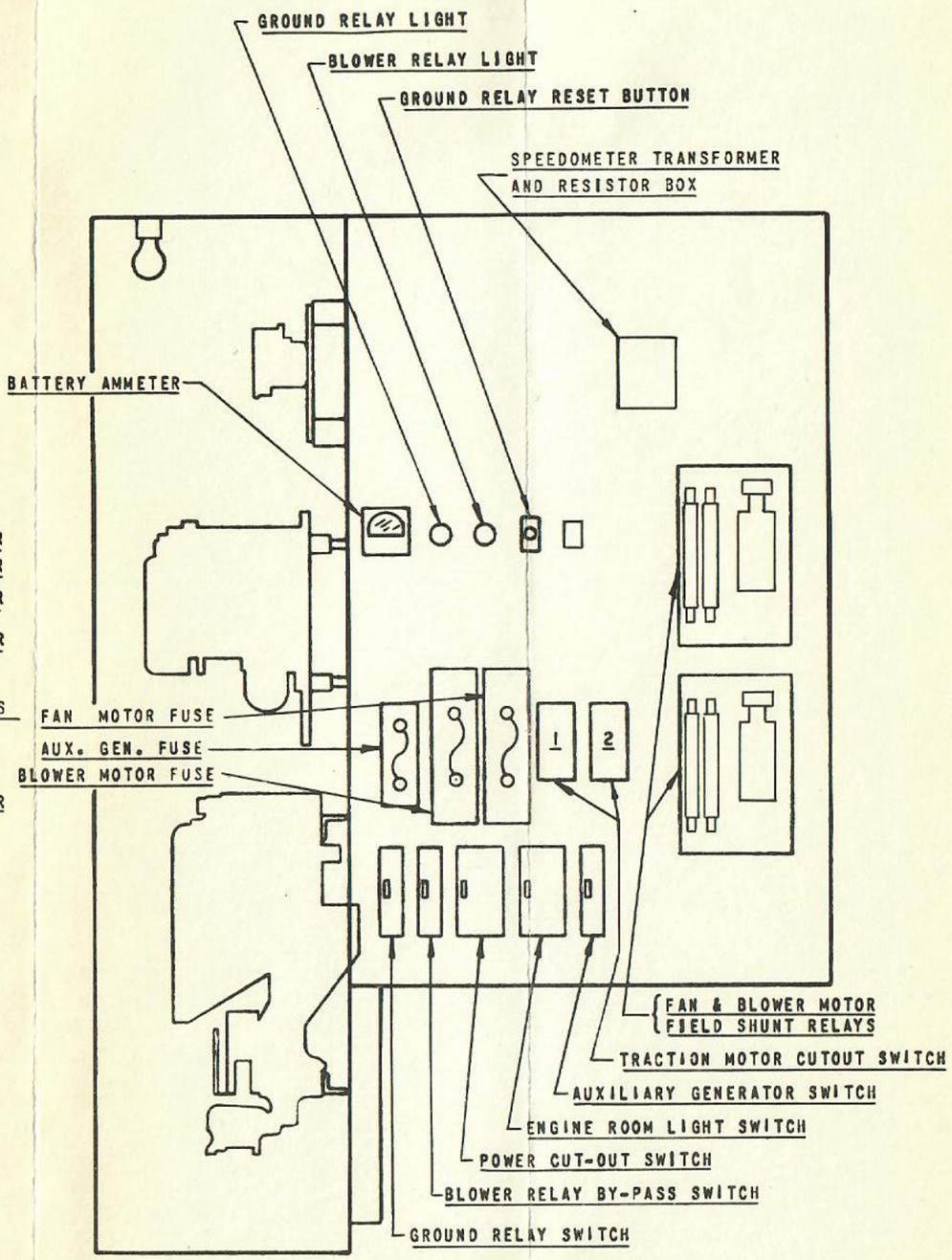


RIGHT SIDE VIEW



LEFT SIDE VIEW

EQUIPMENT CABINET - "B" UNIT
Figure 5

MAIN POWER CIRCUIT

The Power Circuits as shown in Fig. 6 show the connections between the main generator and the traction motors. This is similar to the heavy duty portion of the Schematic Diagram in Fig. 2, except that the connections of the traction motor fields, field shunts, reversers, pneumatic power switches, field shunt relays, wheel slip relays and load ammeter are also shown. The positive side of the main generator is connected to the four traction motors permanently arranged in series-parallel (i.e., two motors in series with each other in circuits which are in parallel). The current, after passing thru the traction motor armatures, reaches the reverser and fields and then proceeds through the main generator commutating field windings and the exciter differential field windings back to the negative side of the main generator armature.

PNEUMATIC POWER SWITCHES

Traction motor power switches, P1 and P2 (shown in Fig. 6), are electro-pneumatically operated by coils P1 and P2 (shown on Fig. 7) and connect the traction motors to the generators. When they are closed, current flows through the power circuit. Manually operated knife switches (TMCO) are connected in series with the coils P1 and P2 which, if opened, prevent the electro-pneumatic power switches from closing. These switches are located in the equipment cabinet.

REVERSERS

The reversers control the direction of rotation of the traction motors by reversing the direction of current through the field windings. On the reverser shown in Fig. 6, the solid or dotted lines show the alternate connections of these fields. They are located in the Equipment Cabinet. The heavy duty contacts are on a drum which is pneumatically operated by coils connected to the reverser drum in the master controller. The control wiring is described in main control circuits.

TRACTION MOTOR FIELD SHUNTS

The traction motor fields are shunted to provide a bypass for a portion of the field current after the

locomotive speed has reached a point where full Diesel engine power output under normal field strength is not absorbed. The field is automatically weakened in several steps, thus increasing speed and making use of practically full output of the motive power unit. Field shunt relays, FS1 and FS2, connected across the generator, are set to close at 820 volts and 850 volts respectively. These two relays control the field shunting contactors (M) for all four traction motors on the power unit. Their action is further described in the text for Main Control Circuits and illustrated in Fig. 7. The field shunt resistors are located in the equipment cabinet.

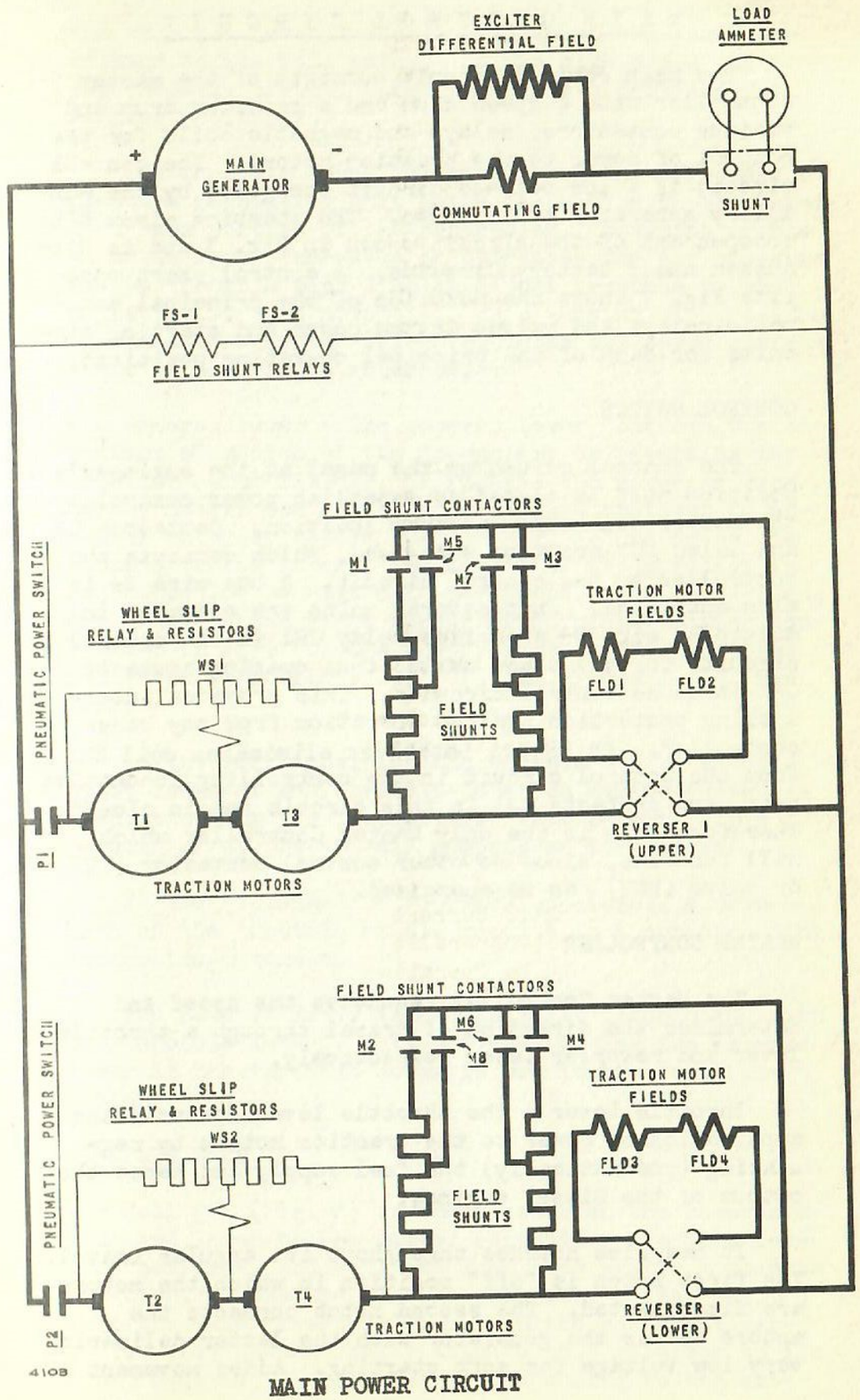
WHEEL SLIP RELAYS

The wheel slip relays and resistors are connected around each pair of traction motors. They operate relays which automatically reduce power when the wheels slip. This is described and illustrated under Miscellaneous Circuits.

Also, if one pair of wheels is locked due to mechanical or electrical failure, the wheel slip buzzer will sound continuously as soon as sufficient speed has been attained to establish a voltage differential from the normally operating traction motors.

LOAD AMMETER

The ammeter is located on the engineer's instrument panel in the cab and is connected in the circuit to show total generator current, which is the sum of the currents in the two parallel traction motor circuits. (See Locomotive Operating Section for load limits.) The shunt for this ammeter is located in the equipment cabinet.



MAIN POWER CIRCUIT
Figure 6

MAIN CONTROL CIRCUIT

The main control circuit consists of the master controller with a speed drum and a reverser drum and various contactors, relays and magnetic coils for the control of power to the traction motors. The control circuit is a low voltage circuit energized by the auxiliary generator at 75 volts. The starting circuit is independent of the circuit shown in Fig. 7 and is discussed under Battery Circuits. A control chart opposite Fig. 7 shows the position of the principal automatic relays and valves in the power and starting circuits for each of the principal operating positions.

CONTROL SWITCH

The control switch on the panel at the engineer's position must be closed to establish power control by the master controller at that location. Contactor CR and valve MCV are thus energized, which connects the controller to the control circuit. A bus wire B+ is also energized. When several units are operated in multiple, wire B+ energizes relay CR1 in the control circuits for all other units, thus opening contacts CR1 in those control circuits. This provides interlocking protection against operation from any other controller. The CR-out interlock eliminates coil CR1 from the control circuit in the controlling locomotive unit, and contacts CR1 in this circuit remain closed. Therefore this is the only Master Controller which will function, since no other control contactor (CR) or valve (MCV) can be energized.

MASTER CONTROLLER

The Master Controller regulates the speed and determines the direction of travel through a throttle lever and reverser lever respectively.

Throttle Lever - The throttle lever controls the application of power to the traction motors by regulating (pneumatically) the fuel supply and hence the output of the Diesel engines.

It has five notches throughout its angular travel. The first notch is "off" position in which the motors are disconnected. The second notch connects the motors across the generator with the latter delivering very low voltage for soft starting. Added movement of

the throttle lever gradually builds up the generator voltage to its full value. At the high speed end of the throttle travel, three notches are provided for running positions.

The throttle lever actuates, by means of a cam, a pressure regulating unit which is located in the lower left hand portion of the controller. Movement of the throttle lever increases or decreases the air pressure in the throttle pipe line in direct response to the magnitude of this movement. This varying air pressure operates an actuator which regulates the speed control shaft of the engine governor.

Reverse Lever - The reverse lever controls the direction of motion of the locomotive by reversing the traction motor fields. It rotates the reverser drum in the master controller which closes contacts to energize reverser relays FOR and REV, according to the setting of the lever. The action of these relays is described in the next main paragraph. The connections are shown in the right hand portion of the master controller in Fig. 7. The lever can be placed in three positions as follows: 1. Off 2. Forward 3. Reverse

In the "off" position the engines can be speeded up by means of the throttle lever to maximum speed without moving the locomotive. This permits rapid pumping of air by the air compressor if necessary.

In the "Reverse" or "Forward" position, a movement of the throttle handle results in a corresponding locomotive movement.

The reverse lever is mechanically interlocked with the throttle lever. This prevents moving the reverse lever if the throttle lever is not in the "off" position.

REVERSER DRUM

Coil FOR (Fig. 7) is energized when the reverse drum and lever on the master controller are in a forward position, and coil REV when they are in a reverse position. These are electro-pneumatic coils, built into the main reverser located in the equipment cabinet. They pneumatically actuate this reverser so its drum revolves to a setting corresponding to the set-

ting of the reverse lever. The contacts on the drums, shown in Fig. 7, Main Power Circuit, close the fields of the traction motors so that the proper direction of rotation of the motors results. Interlocks FOR and REV close for their respective positions of the reverse lever, and connect to a common terminal on the power cut-out switch, through which the coils EF and GF are fed.

TRACTION MOTOR FIELD SHUNT RELAYS

As the locomotive speed increases, two steps of automatic field shunting occur. Relays FS1 and FS2 (Fig. 7) successively close contactors M1 to M4 and contactors M5 to M8 inclusive, which decreases the traction motor fields when armature current drops to a preset value. This occurs at speeds of approximately 20 and 31 miles per hour. There is a sudden increase of about 100 amperes motor current (200 generator amperes) as the locomotive accelerates past these speeds. These relays, contactors and field shunting resistors are mounted in the equipment cabinet.

GENERATOR AND EXCITER FIELD CONTACTORS

Electro-magnetic contactors, GF and EF, in the equipment cabinet, must be closed to complete field circuits for the main generator and exciter. These contactors close when current flows through the corresponding coils in Fig. 7. When the engine is idling, or the generator isolated, the circuit through Engine Start, FR-Out, P1-Out, and P2-Out etc., provides current for the field relays GF and EF in order to maintain power supply to the fan motors. When the reverser is thrown to a Forward or Reverse position, relay FR is energized, the circuit through relays P1 and P2 closes, and the field relays are energized through interlocks P1-in and P2-in instead of P1-out and P2-out, which are now open.

Start Button #1 is a double contact push button with one contact normally closed as shown in Fig. 7, and one contact normally open as shown in Fig. 10 and 11. The normally closed contact opens during starting to de-energize GF and EF, thus disconnecting the exciter and its field.

TRACTION MOTOR CUTOUT SWITCHES

Coils P1 and P2 (Fig. 7) operate electro-pneumatic power switches P1 and P2 (Fig. 6) which was discussed in the Main Power Circuits. Double-pole Traction Motor Cutout Switches (TMCO) are connected in series with these coils, and may be manually opened to de-energize coils P1 and P2 which opens the corresponding power circuit. The second pole of the TMCO switch is in the exciter field circuit (Fig. 11). When opened it adds resistance to this circuit to reduce the field, and hence the generator output, when full power is not needed due to the corresponding traction motor being disconnected. These switches should not be operated while power is applied. The power switches and the TMCO switches are all located in the equipment cabinet.

POWER KNOCKOUT SWITCH

This is a pneumatically operated switch which opens the control circuit between the auxiliary generator and the master controller. It opens when an emergency brake application is made, or when the Deadman Control is released. It shuts off power from the generator and brings the engine down to idling speed. This action is the same as if the throttle on the master controller were shifted to "off" position. The switch is located in the nose at the front of the locomotive. It closes automatically when the brake lever or deadman pedal are returned to normal operating condition.

DEADMAN CONTROL

The deadman control pedal is a pneumatic device which performs three functions if released while the locomotive is running:

1. Pneumatically opens the power knockout switch in the electric control circuit. The engine idles.

2. Reduces pressure to the emergency cutoff valve in the controller which reduces the fuel supply just as though the throttle were set back.

3. Applies the brakes.

The only electrical action is that associated with

the power knock-out switch. The Control System Diagram in Fig. 1 shows the basic line of action for functions 1 and 2 above. See Section 6, for the air piping.

POWER CUTOUT SWITCH

Each power unit has a power cutout switch which when opened, completely disconnects the fields and power circuits of the unit. The fans and blowers will also stop. These switches are located in the equipment cabinet.

EMERGENCY ENGINE SHUTDOWN SWITCHES

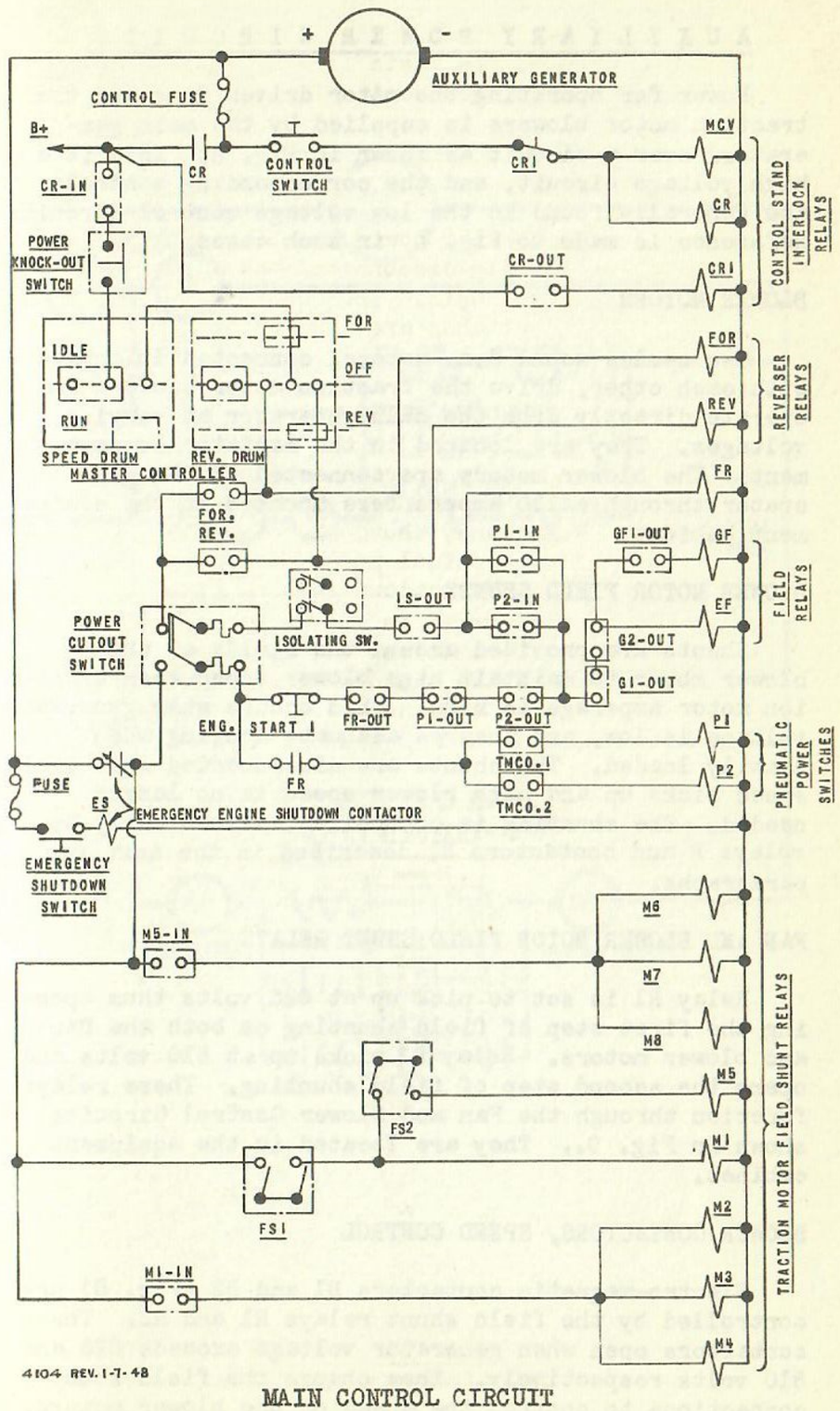
Closing the manually operated emergency engine shutdown switch on the engineer's control panel, energizes (opens) emergency shutdown contactor ES, opening the circuits to the fuel pump motors, power cutout switch, and engine shutdown switch. See Figures 7, 9 and 10. Contactor ES is located in the equipment cabinet. Whenever locomotives are operated in multiple, this switch operates the shutdown contactors in all locomotives connected together.

CONTROL CHART

POSITION OF APPARATUS IN FIGURES 8 AND 12

Operation	Manual Controls										Automatic Equipment											
	Reverse Lever	Throttle Lever	Isolating Switch (O=On)	Engine Shutdown Switch	Power Cutout Switch	Traction Motor Cutout Switch	Control Button	Start Button No. 1	Start Button No. 2		CR,	SDV	G1, G2, GF1	GF 2	EF GF	P1, P2	FS1, M1, M2, M3, M4	FS2, M5, M6, M7, M8	TV			
LOCOMOTIVE SHUTDOWN		I																				
ENGINE START, STEP 1		I	O	O	O	O	O	O			O	O	O	O								
ENGINE START, STEP 2		I	O	O	O	O	O	O	O		O	O	O									
ENGINE IDLE		I	O	O	O	O	O				O	O			O							
ENGINE RUN		R	O	O	O	O	O				O	O			O							
LOCOMOTIVE RUN	X	R	O	O	O	O	O				O	O			O	O						
LOCOMOTIVE RUN, FIELD SHUNT 1	X	R	O	O	O	O	O				O	O			O	O	O					
LOCOMOTIVE RUN, FIELD SHUNT 2	X	R	O	O	O	O	O				O	O			O	O	O	O				
ENGINE ISOLATED	X	IR		O	O	O	O				O	O			O				O			

O—Closed or engaged position. Equipment is open or disengaged when not shown closed.
X—Forward or Reverse.
I—Idle.
R—Run.



4104 REV. 1-7-48

MAIN CONTROL CIRCUIT
Figure 7

A U X I L I A R Y P O W E R C I R C U I T S

Power for operating the motor driven fans and the traction motor blowers is supplied by the main generators over a circuit as shown in Fig. 8. This is a high voltage circuit, and the corresponding controls are generally found in the low voltage control circuit. Reference is made to Fig. 9 in such cases.

BLOWER MOTORS

Two series wound d.c. motors, connected in series with each other, drive the traction motor blowers and operate directly from the main generator at varying voltages. They are located in the radiator compartment. The blower motors are connected to the generator through a 110 ampere fuse mounted in the equipment cabinet.

BLOWER MOTOR FIELD SHUNTS

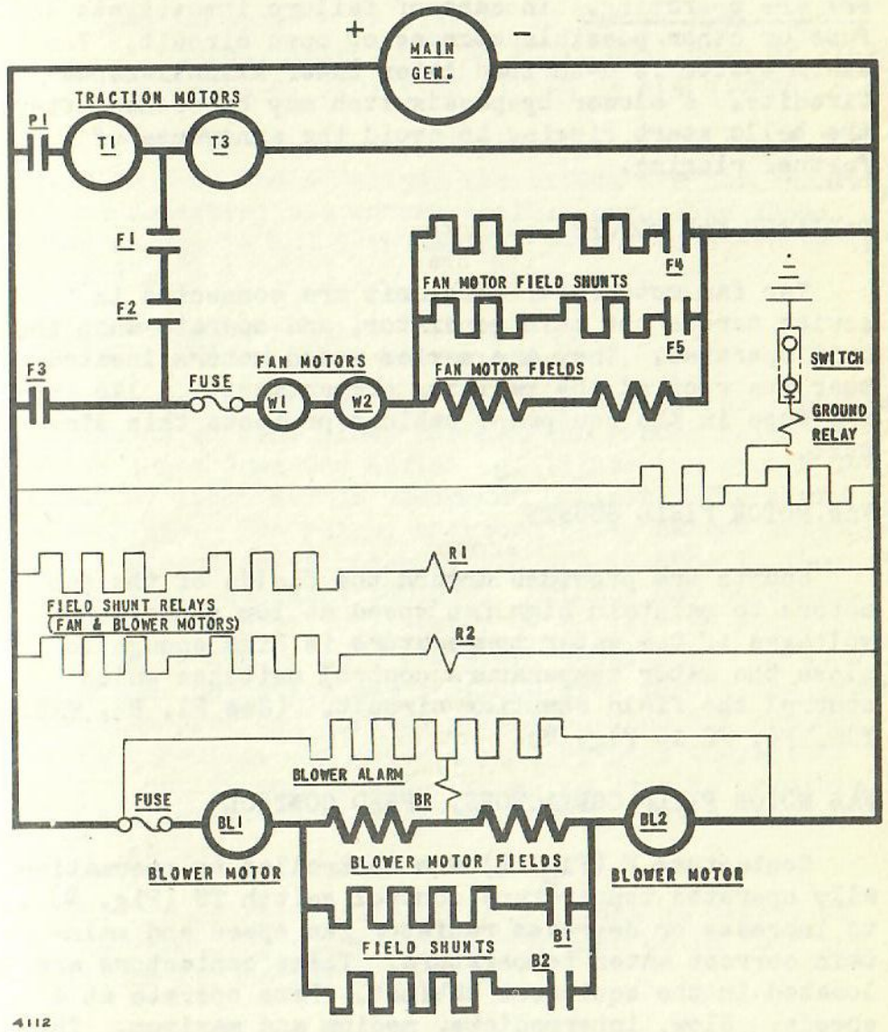
Shunts are provided around the fields of the blower motor to maintain high blower speed when traction motor amperage is high. This occurs when generator voltage is low, and insures adequate cooling when heavily loaded. The shunts are disconnected when train speed picks up and high blower speed is no longer needed. The shunting is controlled automatically by relays R and contactors B, described in the next two paragraphs.

FAN AND BLOWER MOTOR FIELD SHUNT RELAYS

Relay R1 is set to pick up at 625 volts thus opening the first step of field shunting on both the fan and blower motors. Relay R2 picks up at 810 volts and opens the second step of field shunting. These relays function through the Fan and Blower Control Circuits shown in Fig. 9.. They are located in the equipment cabinet.

BLOWER CONTACTORS, SPEED CONTROL

Electro-magnetic contactors B1 and B2 (Fig. 8) are controlled by the field shunt relays R1 and R2. These contactors open when generator voltage exceeds 625 and 810 volts respectively. They change the field shunt connections to control the speed of the blower motors. These contactors are located in the equipment cabinet.



AUXILIARY POWER CIRCUIT
Figure 8

BLOWER STOPPED INDICATION

If the blowers stop, the alarm bells ring and a blower indicator light in the equipment cabinet lights. The power unit must not haul a train unless the blowers are operating. In case of failure investigate the fuse or other possible sources of open circuit. The alarm system is described later under Miscellaneous Circuits. A blower by-pass switch may be opened after the bells start ringing to avoid the annoyance of further ringing.

RADIATOR FAN MOTORS

Two fan motors for each unit are connected in series across the main generator, and operate when the unit operates. They are series wound motors located near the roof of the radiator compartment. A 175 ampere fuse in the equipment cabinet protects this circuit.

FAN MOTOR FIELD SHUNTS

Shunts are provided around the fields of the fan motors to maintain high fan speed at low generator voltages if the water temperature is high enough to close the water temperature control switches which control the field shunting circuit. (See R1, R2, TS3, TS4, F4, F5 in Fig. 9).

FAN MOTOR FIELD CONTACTORS, SPEED CONTROL

Contactors F (Fig. 8) are controlled by pneumatically operated temperature control switch TS (Fig. 9), to increase or decrease radiator fan speed and maintain correct water temperature. These contactors are located in the equipment cabinet. Fans operate at 4 speeds: Slow, intermediate, medium and maximum. The circuit for each speed is as follows:

Slow Speed - From a point midway between the two traction motors through contactors F1 and F2 to the fields, contactor F3 being open. This puts only half the generator voltage across the fan motors.

Intermediate - F1 and F2 open and F3 closes, putting full generator voltage across the two fan motors.

Medium Speed - F4 closes, F3 remaining closed, causes partial shunting of motor fields while retaining full generator voltage on the motor, providing R2 is closed.

Maximum Speed - F5 closes, F3 and F4 remaining closed, introduces an additional step of field shunting, providing R1 and R2 are closed.

If the main generator voltage is sufficiently high to open the R relays, the fields are not shunted, thus protecting the motors against excessive speed. (See relays TS and R in series, F4 and F5 circuits in Fig. 9).

GROUND RELAY

If any portion of the high voltage circuit becomes grounded, current flows through the ground relay GR which shuts down the engine and lights the ground indicating light at the equipment cabinet. The alarm also rings. The relay, a ground relay cutout switch and a ground relay reset switch are located in the electrical equipment cabinet. Grounds may be caused by excessive dirt, oil, water or faulty interlocking, and may be due to some transient condition. In some instances operation may continue even though the ground persists provided serious grounding does not produce short circuits. If necessary to by-pass the ground relay, notify maintenance forces as soon as possible. The following instructions are posted inside the equipment cabinet.

The ground relay cut-out switch must be closed and the ground relay re-set switch must be in "on" position for normal operation.

To re-set ground relay throw ground relay re-set switch to "off" position then return to "on" position.

If necessary to by-pass ground relay throw the ground relay re-set switch to "off" position and open the ground relay cut-out switch.

AUXILIARY CONTROL CIRCUITS

The controls for the Fuel Pumps, the Traction Motor Blowers, and the Radiator Shutter and Fans receive their power from the auxiliary generator, which also supplies the fuel pump motors. A description of these circuits, as shown in Fig. 9, follows.

FUEL SUPPLY PUMP

The motor driven fuel supply pump for each power unit receives power through a manually operated single-pole breaker-type switch located on each of the engine room control panels. The compound-wound motor mounted on the bed-plate on the exhaust side of each engine operates at constant speed, supplying fuel oil from the supply tank to the engine fuel injection pumps. It is fed through the normally closed emergency engine shutdown contactor ES.

The foregoing portion of the circuit is shown in Fig. 9. The coil which operates the shutdown contactor, and manually operated emergency shutdown switch are shown in Fig. 7. Closing the emergency shutdown switch on the engineer's control panel energizes shutdown relay ES, opening the circuit supplying the fuel pump motors and cutting off the fuel supply.

BLOWER SPEED CONTROL

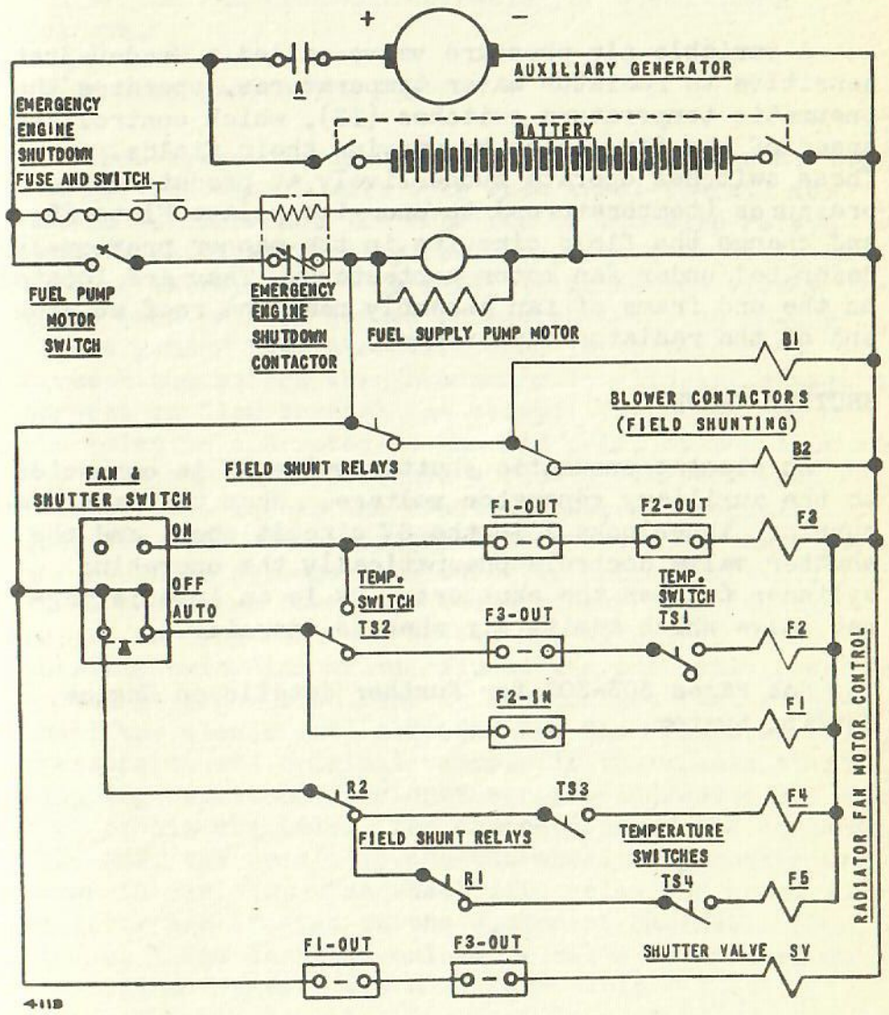
Contactors B1 and B2 regulate the blower speed by controlling the field shunting in the blower motor circuit. When the generator voltage exceeds the settings of the field shunt relays (R), the circuits to the coils B1 and B2 are opened, which de-energizes the coils and opens contactors in the field shunt circuits, as previously described in the Auxiliary Power Circuit.

FAN AND SHUTTER SWITCH

The fan and shutter switch is a small double-pole double-throw manually operated switch located on the engine room control panel and connected as shown in Fig. 9. The switch has three positions, as follows:

Off - Fans will not operate. Shutters are closed.

On - Fans operate at medium speed. Shutters may be adjusted by hand. This provides emergency



AUXILIARY CONTROL CIRCUIT
Figure 9

manual control if automatic control fails.

Automatic - Fan speed automatically regulated thru temperature control switches.

TEMPERATURE CONTROL SWITCHES

A variable air pressure valve called a Grad-U-Stat, sensitive to radiator water temperatures, operates the pneumatic temperature switches (TS), which control the speed of the fan motors by varying their fields. These switches operate successively at predetermined pressures (temperatures) to energize relays F1 to F5, and change the field circuits in the manner previously described under fan motor contactors. They are located on the end frame of fan assembly near the roof at each end of the radiator compartment.

SHUTTER VALVE

An electro-pneumatic shutter valve SV is connected to the auxiliary generator voltage. When the fans are running, interlocks F in the SV circuit open, and the shutter valve controls pneumatically the operating cylinder to open the shutters. SV is an inverse magnet valve which admits air when de-energized.

See Pages 303-307 for further details on Engine Cooling System.

MISCELLANEOUS CIRCUITS

In addition to the foregoing controls, various miscellaneous controls are supplied by the auxiliary generator over circuits shown in Fig. 10. A description of the function and operation of these items follows.

WHEEL SLIP PROTECTION SYSTEM

This system automatically limits the speed at which the driving wheels will spin when wheel-to-rail adhesion is exceeded. It consists of two slip relays (WS1, WS2), a slip relay resistor, and a throttle unloading valve, TV1. One relay is connected midway between each pair of series connected traction motors in such a manner that the difference in voltage-drop through the motors when one motor is slipping causes a current to flow through the relay. The other end of the relay is connected to the mid point of the slip relay resistor which prevents a flow of current when the voltage loss across the traction motors is equal. (See Fig. 6.) Each coil operates a pair of contactors, one of which actuates the throttle unloading valve (TV) while the other furnishes the engineer with audible buzzer warning that the wheels are slipping. The throttle unloading valve reduces the pneumatic pressure on the governor resulting in a decreased fuel supply until the wheels stop slipping and then restores the pressure to its original value. If the wheels start slipping repeatedly the engineer should reduce the setting of his throttle. The connections of the contacts WS1, WS2, the coil TV1, and the wheel slip buzzer are shown in Fig. 10. The wheel slip relay and wheel slip resistor are located in the equipment cabinet. (See Fig. 4.) The throttle unloading valve is mounted on the engine frame. (See also page 416.)

ENGINE STOP SWITCH

The engine stop switch is connected in series with a shutdown valve SDV which controls the fuel supply. The switch is opened to cut off the fuel supply and stop the engine. It is a toggle switch located on engine room control panel.

ENGINE SHUTDOWN VALVE

This solenoid-operated valve controls the fuel supply through coil SDV which must be energized to

maintain fuel supply. A circuit through the starting button energizes this coil when starting the engine. As soon as oil pressure builds up, the lube oil pressure switch closes and keeps the coil energized. When the engine is operating, it shuts down if SDV is de-energized by a pick up of the Ground Relay or by opening the Engine Stop Switch or the Lube Oil Pressure or Temperature Switches. Other details of this valve are shown in Fig. 5, Section 3.

ISOLATING SWITCH

The manually operated two-pole isolating switch on the engine room control panel disconnects the load and isolates the power unit when thrown to the "off" position. In this position, contactor FR is de-energized, which opens the traction motor circuits, (see Fig. 7), and throttle unloading valve TV is energized which reduces the engine speed to idling by its pneumatic action on the governor and fuel supply. The generator fields remain excited to provide power for the fans, since the series of out-interlocks, fed by the other pole of the power cutout switch, close.

ISOLATING CONTACTOR

An isolating contactor, located in the equipment cabinet, is energized if the hot water temperature switch closes. An IS-in interlock in the throttle valve circuit closes which idles the engines. Also, an IS-out interlock in series with the isolating switch opens which de-energizes (opens) FR and the P power switches. The closed contactor rings the alarm bell.

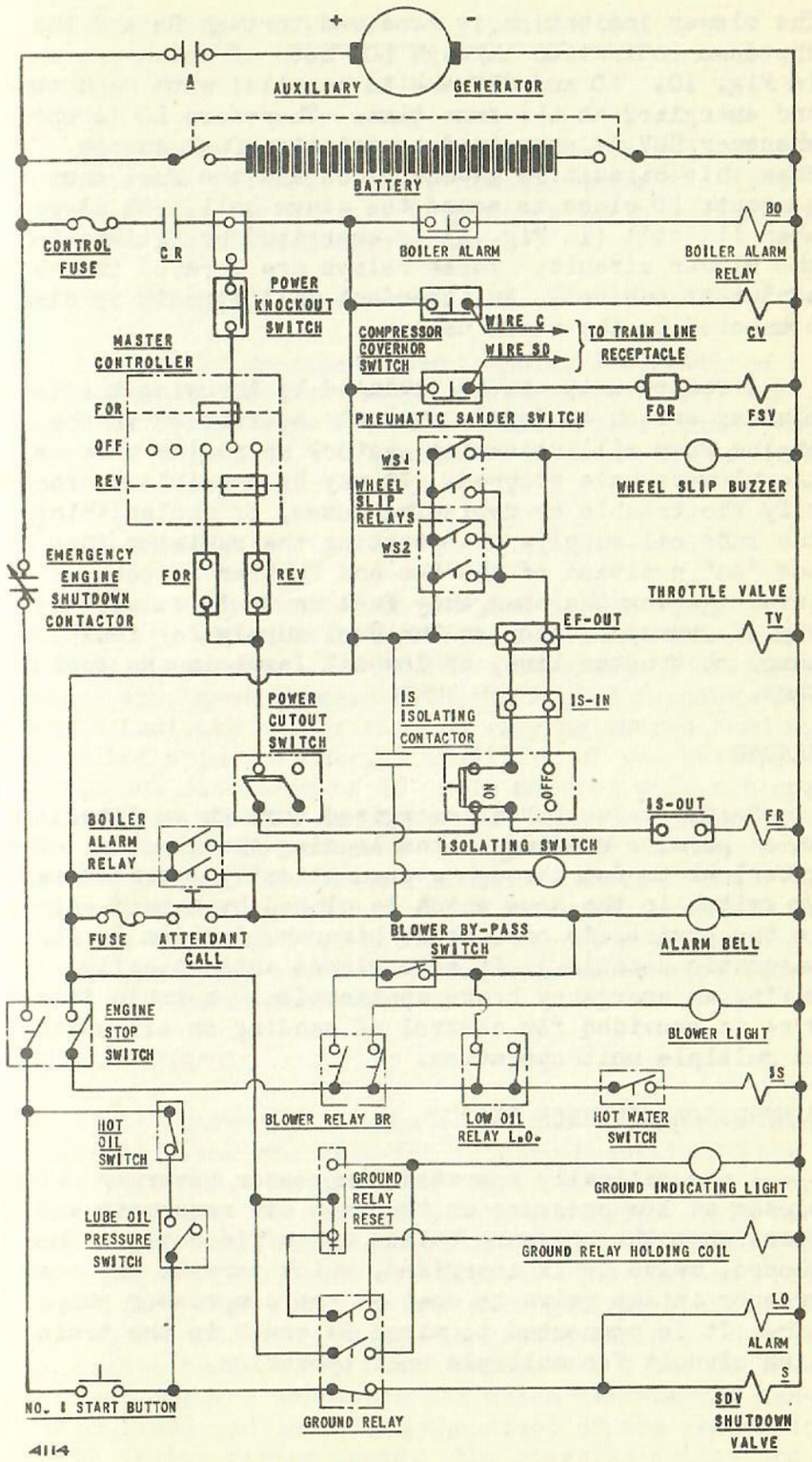
MISCELLANEOUS SWITCHES

LUBE OIL PRESSURE SWITCH automatically opens when lubricating oil pressure drops below a predetermined value. It acts on Shutdown Valve as just described.

HOT OIL SWITCH automatically opens at high oil temperatures and de-energizes Shutdown Valve SDV.

HOT WATER TEMPERATURE SWITCH automatically closes at high water temperatures and energizes the Isolating Contactor idling the engine.

These switches are mounted on the engine.



MISCELLANEOUS CIRCUITS
Figure 10

The blower indication is received through BR and the shutdown indication through LO, both of which are shown in Fig. 10. LO and SDV are in parallel with each other and energized at the same time. Therefore LO is open whenever SDV is energized to maintian fuel supply. When this circuit is de-energized and the fuel shut off, contacts LO close to sound the alarm bell. BR closes when its coil (in Fig. 8) is energized by failure in the Blower circuit. These relays are located in the equipment cabinet. An Attendant Call circuit is also connected to the alarm bell.

A faulty unit can be isolated by throwing the isolating switch to "off". Visual observation in the engine room will determine whether an engine unit or the blowers have stopped. It may be possible to rectify the trouble by replacing fuses, or replenishing the lube oil supply, or operating the radiator fans in the "on" position of the Fan and Shutter Switch, or investigating the emergency fuel shut-off valve, the engine overspeed stop or the fuel supply for faulty pump, obstructed line, or low oil level in the fuel tank.

SANDER

Sander valve FSV is energized through an interlock which permits sanding on the leading wheels only. The interlock is fed through a pneumatically operated sander switch in the nose which is closed by a hand valve in the engineer's cab. (See Diagram, Section 6, for pneumatic details.) It also closes automatically during an emergency brake application. A train line wire is provided for control of sanding on all units in multiple unit operation.

COMPRESSOR GOVERNOR SWITCH

A pneumatically operated compressor governor switch closes at low pressure on the main air reservoir and opens when the pressure builds up sufficiently. When closed, valve CV is energized, which permits the compressor intake valve to seat so the compressor pumps air. It is connected to wires B+ and C in the trainline circuit for multiple unit operation.

B A T T E R Y C I R C U I T S

BATTERY

Each locomotive unit is equipped with a 32-cell 75 volt storage battery. It is mounted under the floor and is accessible through trap doors in the passageway on each side of the engine room.

BATTERY CUTOUT SWITCH

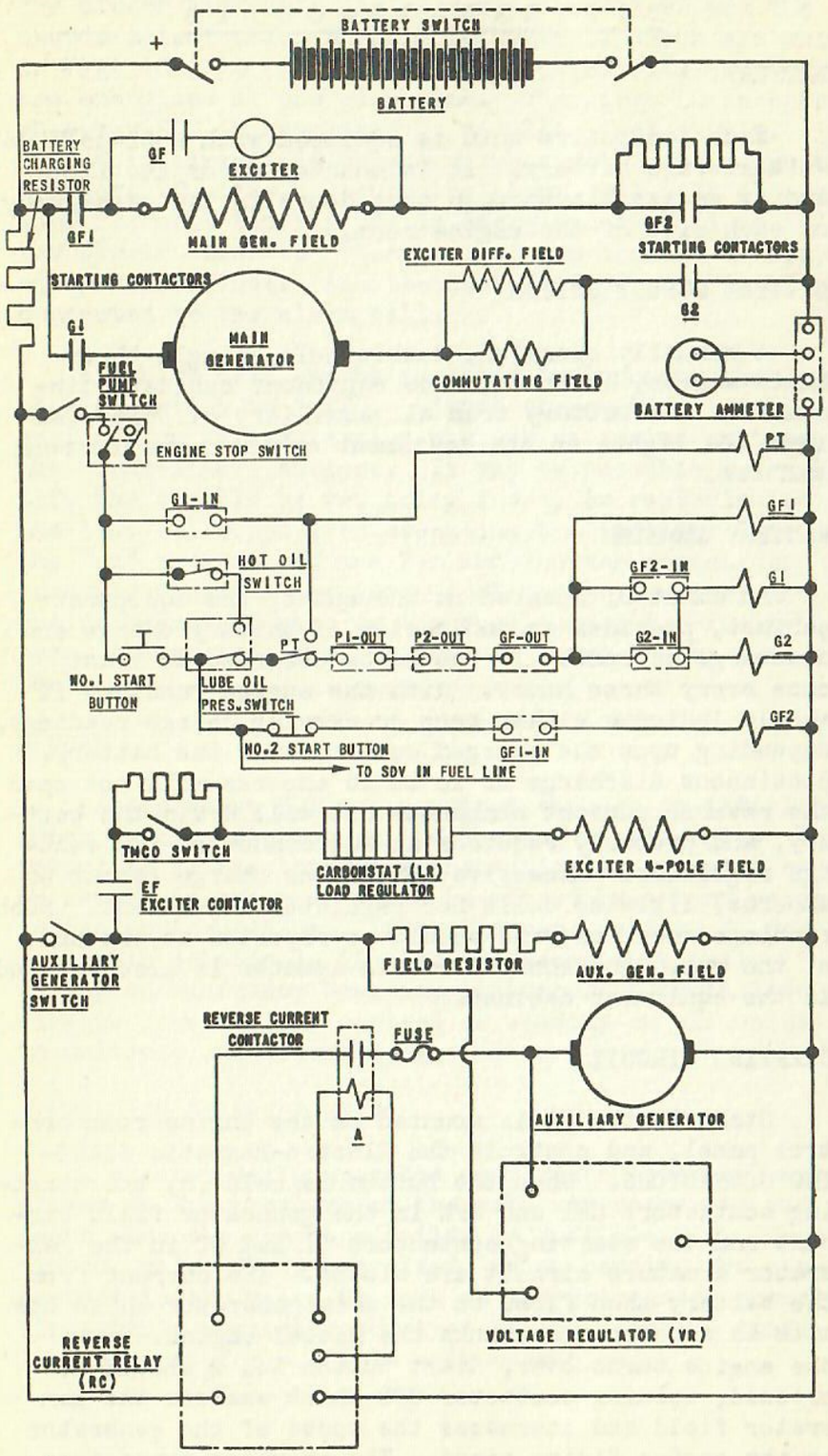
A manually operated, double-pole, single-throw knife switch, located in the equipment cabinet, disconnects the battery from all auxiliary circuits, except the lights in the equipment cabinet, engine room and cab.

BATTERY AMMETER

An ammeter, located on the end of the equipment cabinet, provides an indication of battery charge and discharge current. It should be observed at least once every three hours. With the engine running, it should indicate either zero or varying charge readings, depending upon the charged condition of the battery. Continuous discharge of 10 to 15 amperes will not open the reverse current contactor but will drain the battery, and probably requires an adjustmnet of the voltage regulator. Excessive continuous charge (about 50 amperes) likewise calls for regulator adjustment. Such readings when observed should be reported at the end of the run. The shunt for this ammeter is also located in the equipment cabinet.

STARTING CIRCUIT

Start Button #1 is mounted on the engine room control panel, and controls the Electro-Magnetic STARTING CONTACTORS. When the button is held in, the starting contactors GF1 and GF2 in the generator field circuit and the starting contactors G1 and G2 in the generator armature circuit are closed. The current from the battery then flows to the main generator which now acts as a motor and cranks the Diesel engine. When the engine turns over, Start Button No. 2 should be pressed, opening contactor GF2 which weakens the generator field and increases the speed of the generator to the engine firing speed. The starting contactors are located in the Electrical Equipment Cabinet.



BATTERY CIRCUITS
Figure 11

Armature contactors G1 and G2 are interlocked to prevent them from closing until the field contactors GF1 and GF2 are closed. If this were not done, the armature would short circuit the battery. A starting protective relay (PT) picks up as soon as normal battery voltage is exceeded. This de-energizes (opens) G1 and G2 which disconnects the main generator as soon as the engine fires and prevents it from feeding the battery. When lube oil pressure has built up to 20 pounds, the Lube Oil Pressure Switch automatically changes to its normal operating position which keeps SDV (in the fuel supply line) energized regardless of the position of the Start Button (See Fig. 10). The Start Buttons may then be released. The gauge indicating the oil pressure is adjacent to the Start Buttons. (Note: Start Button #1 has a second set of normally closed contacts which are opened during starting to disconnect the exciter and its field, as previously stated on page 420.)

AUXILIARY GENERATOR SWITCH

The auxiliary generator switch must be closed to excite the field and enable the auxiliary generator to supply its normal load. It is open during starting, to reduce the load on the battery. It is a manually operated toggle switch located on the equipment cabinet.

CARBONSTAT LOAD REGULATOR

The exciter 4-pole field is energized by the auxiliary generator through Contactor EF which automatically closes immediately after starting. A Carbonstat (LR) is connected in series in this circuit. This is a hydraulically operated resistance changing device mounted on the engine chain drive casing consisting of a carbon pile resistor held under pressure by a spring. The spring is sensitive to changes in the governor and also, by pneumatic connection, to changes in the throttle mechanism. As the pressure changes, the resistance is varied which changes the current through the exciter field. This prevents overloading or underloading of the electrical equipment and also provides smooth acceleration when starting.

BATTERY CHARGING

The battery is automatically charged by the aux-

iliary generator which is controlled by a vibrating type voltage regulator so that the voltage is substantially constant at the various operating speeds of the Diesel engine. The reverse current relay automatically connects the battery and the auxiliary generator after the engine starts. This equipment is described in the following paragraphs. The battery may also be charged from terminal or shop circuits through the charging receptacle outside the battery compartment.

VOLTAGE REGULATOR

The voltage regulator holds the auxiliary generator voltage constant over the normal operating speed range of the Diesel engine. A voltage relay element varies the auxiliary generator shunt field current to hold constant voltage regardless of engine speed and auxiliary load. A current limiting element prevents prolonged overload on the auxiliary generator. Under such conditions, the regulated voltage is reduced by the deflection of a bi-metallic heater element which compresses a carbon pile resistor connected to the voltage element. The intermittent operation or vibration of the moving contacts causes a light sparking which is audible at close proximity. The rheostat in the regulator is adjusted to give proper generator voltage and should not be changed by unauthorized personnel. The regulator is located in the equipment cabinet.

REVERSE CURRENT RELAY AND CONTACTOR

The reverse current relay has two automatic functions. It connects the auxiliary generator to the battery through contactor A when the generator voltage is sufficiently high to charge the battery, and protects against a reverse flow of current from the battery, when the generator voltage is too low, by opening the circuit.

Connections are made by means of voltage coils which close contacts in the circuit to contactor A when the generator voltage is about 1 volt above battery voltage. After the contactor closes, this voltage no longer affects the relay. It is therefore necessary to open the circuit by means of another coil which measures the current in the circuit between the auxiliary generator and battery. This coil opens contactor A when the reverse current reaches a magnitude of about 20 to 25 amperes. Both the relay and contactor are located in the electrical equipment cabinet.

L I G H T I N G C I R C U I T S

The following lights and fans are connected to the auxiliary generator, or to the battery when the auxiliary generator is not working except the Cab Heater Fans which operate from the auxiliary generator only.

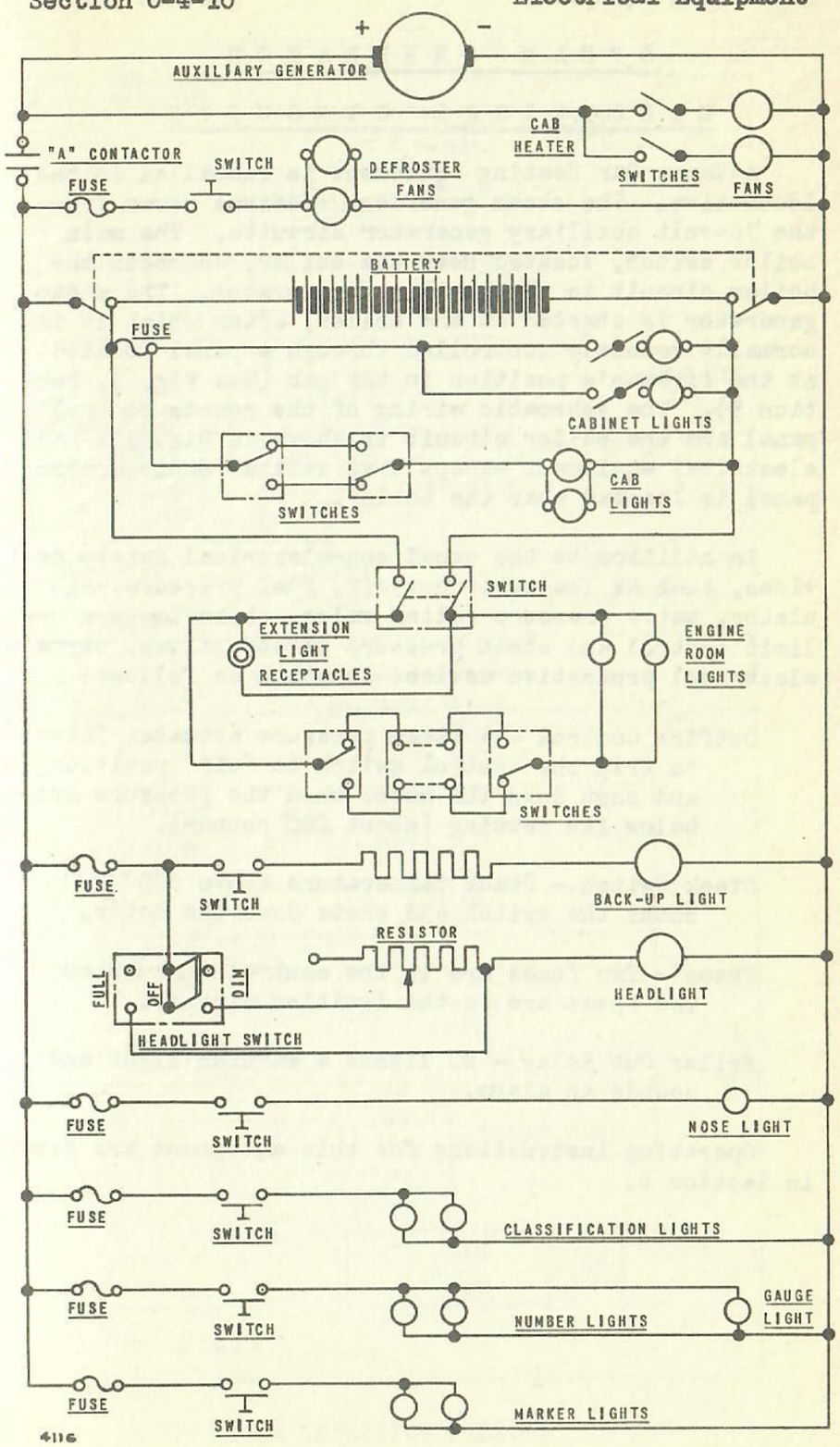
Front Headlight
Back-up Light
Nose Light
Cab Lights
Engine Room Lights
Classification Lights
Gauge and Number Lights
Marker Lights
Cabinet Light
Cab Heater Fans
Defroster Fans

Figure 13 shows the connections for this equipment.

A three position switch above the engineer's side window controls the headlight. A resistor in series with the "dim" position of this switch dims the headlight. The headlight is fused through the fuse in the Control Push Button Box. (But the push button is not connected in the circuit.) All switches controlling these circuits are located in the engineer's cab except as follows:

Battery Switch - In equipment cabinet.
Engine Room Light Master Switch - In equipment cabinet.
Cabinet Light Switches - At the light.

The engine room lights may also be turned on or off by switches located at the entrance to the locomotive. Receptacles for extension lights are located in the engine room. They are fed through the Engine Room Light Master Switch.



LIGHTING CIRCUITS
Figure 12

STEAM GENERATOR

ELECTRICAL CIRCUITS

A Vapor Car Heating equipment is installed in the locomotive. The steam generator receives power from the 75-volt auxiliary generator circuits. The main boiler switch, located near the boiler, connects the boiler circuit to the auxiliary generator. The steam generator is started at the boiler, after which it is normally remotely controlled through a panel located at the fireman's position in the cab (See Fig. 1, Section 8). The schematic wiring of the remote control panel and the boiler circuit is shown in Fig. 13. All electrical equipment except that at the remote control panel is located near the boiler.

In addition to the usual non-electrical safety devices, such as low-water cut-off, fuel pressure regulator, water pressure relief valve, steam temperature limit control and steam pressure safety valves, certain electrical protective devices function as follows:

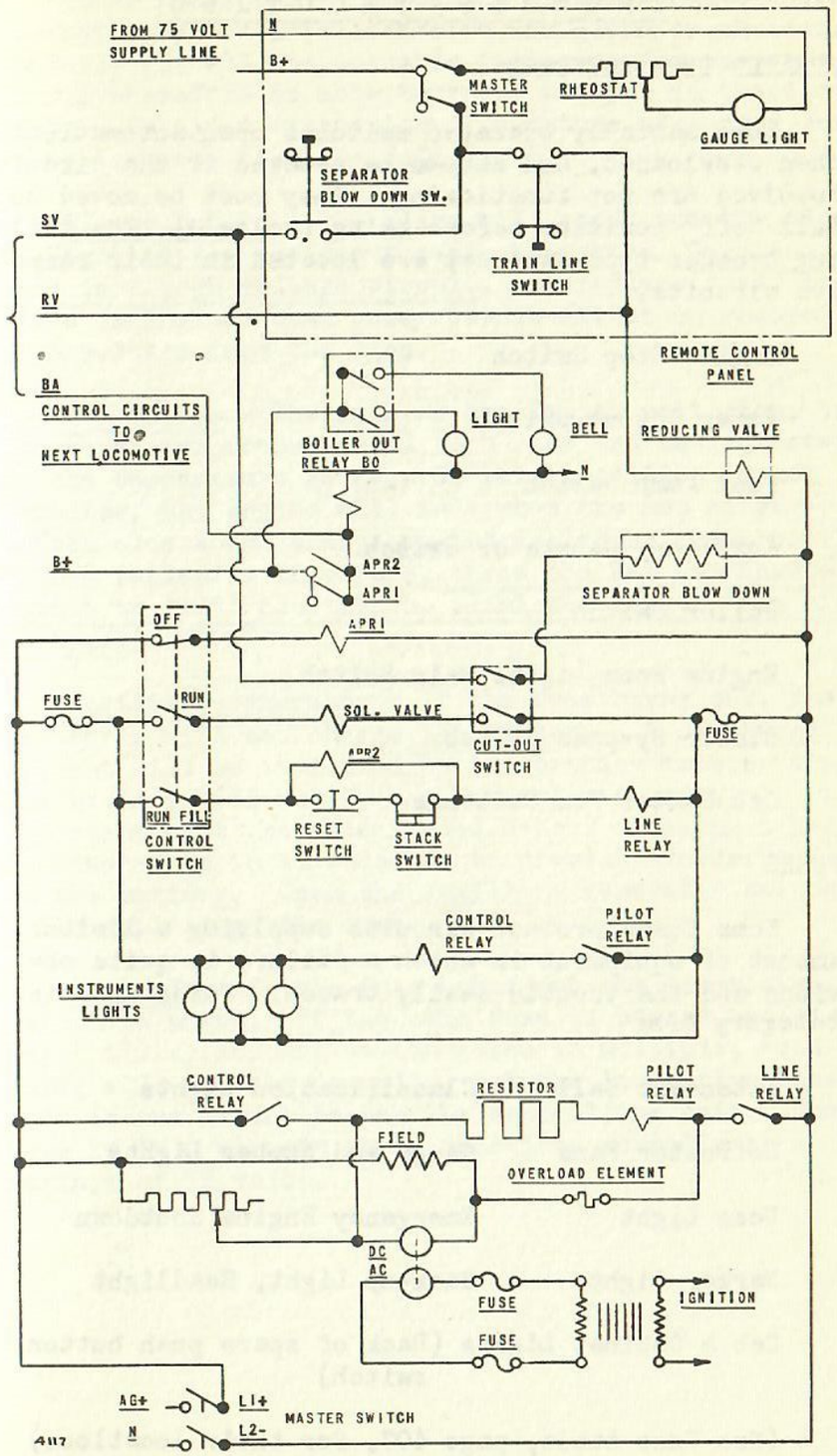
Outfire Control - A steam pressure actuated latch to trip the control switch to "off" position and shut down the motor when the pressure drops below its setting (about 200 pounds).

Stack Switch - Stack temperature above 900° F. opens the switch and shuts down the motor.

Fuses - Two fuses are in the control circuit and two fuses are in the ignition circuit.

Boiler Out Relay - BO lights a warning light and sounds an alarm.

Operating instructions for this equipment are given in Section 8.



STEAM GENERATOR CIRCUIT
Figure 13

TROUBLE SHOOTING

BREAKER TYPE SWITCHES

Some manually operated switches open automatically when overloaded, and should be checked if the circuits involved are not functioning. They must be moved to full "off" position before being reclosed. The following breaker-type switches are located in their respective circuits.

Engine Stop Switch

Power Cutout Switch

Fuel Pump Switch

Auxiliary Generator Switch

Boiler Switch

Engine Room Lights Main Switch

Blower By-pass Switch

Cab Heater Fan Switches

FUSES

Some fuses protect circuits supplying a limited amount of equipment in which a failure is quite obvious and the trouble easily traced. Fuses in this category are:

Attendant Call	Classification Lights
Defroster Fans	Gauge and Number Lights
Nose Light	Emergency Engine Shutdown
Marker Lights	Back-up Light, Headlight
Cab & Cabinet Lights (Back of spare push button switch)	

(See Fuse table, page 407, for their location.)

Other fuses are in important power circuits which are difficult to interlock with the alarm or shutdown features for all the possible failures, and the crew should therefore be able to trace trouble in these circuits. Detailed discussion of symptoms of burned out fuses in these circuits follows.

Blower Motors - The alarm will sound and the blower light at the equipment cabinet lights. Caution: this is a hogh voltage circuit. To replace fuse, isolate engine and open power cutout switch to remove high voltage from the line.

Fan Motors - The fans on the faulty unit stop, and the water temperature will soon rise and be indicated on the temperature gauge. If this condition is not detected, the engine will idle when the hot water switch closes and energizes the isolating contactor. Before replacing this fuse, throw the Fan and Shutter Switch to "off" position to eliminate danger from high voltage.

Auxiliary Generator - If the fuse burns out, the generator will not charge the battery. A discharge current will be indicated by the battery ammeter since the battery will supply the control circuits. It is important that the recommended 3-hour checking schedule be adhered to in an endeavor to prevent excessive drain on the battery. Open the auxiliary generator switch while replacing this fuse.

Control - If this fuse burns out the locomotive cannot be moved. If the same fuse is burned out on any trailing locomotive connected in multiple, both units will operate normally, but the locomotive whose fuse is out cannot become the controlling unit. The fuse is in a circuit which functions normally at a maximum of 75 volts.

E L E C T R I C A L I N D E X

Item	Symbol	Page
Ammeter, Load		416
Ammeter, Battery		435
Alarm, Blower	BR	432
Alarm, Fuel	LO	432
Attendant Call (Alarm)		432
Auxiliary Generator		409
Auxiliary Generator Switch		437
Battery		435
Charging		437
Cutout Switch		435
Reverse Current Contactor	A	438
Reverse Current Relay	RC	438
Blower Alarm	BR	432
Blower Motor	BL	424
Field Shunts		424
Contactors	B	424,428
Stop Indicator Light		426
Carbonstat	LR	437
Compressor Switch		434
Compressor Valve	CV	406,434
Control Deadman		421
Control Switch		418
Control Relay	CR1	418
Control Contactor	CR	418
Controller, Master		418
Electro-Pneumatic Valves		406
Emergency Shutdown Switch (Manual)		422
Emergency Shutdown Contactor	ES	422
Engine Shutdown Valve	SDV	431
Engine Stop Switch		431
Exciter		409
Field Contactor	EF	420,437
Fan Motor	W	426
Field Contactor	F	426
Field Shunt		426
Fan and Shutter Switch		428
Field Shunt Relays	R	424
Field Shunt Relays	FS	416,420
Forward Relay	FOR	419
Fuel Supply Pump	FP	428
Fuel Supply Pump Switch		428
Fuses		407

Item	Symbol	Page
Generator, Main		409
Generator Field Contactor	GF	420
Ground Indicating Relay	GR	427
Headlight, Resistor and Switch		440
Heater Fans		440
Hot Water Temperature Switch		432
Hot Oil Switch	HO	432
Isolating Contactor	IS	432
Isolating Switch		432
Lube Oil Pressure Switch		432
Master Controller		418
Master Controller Cutout Valve	MCV	418
Power Control Contactor	FR	420
Power Switch	P	406,415
Power Cutout Switch		422
Power Knockout Switch		421
Protective Relay	PT	437
Reverser		406,415
Reverse Relay	REV	419
Sander Switch		434
Sander Valve, Forward	FSV	406,434
Shutdown Valve	SDV	431
Shutter Valve	SV	430
Start Buttons		435
Start Contactors	G1,G2,GF1,GF2	435
Temperature Control Switch	TS	430
Throttle		418
Throttle Valve	TV	406,431
Traction Motor	T	410
Cutout Switches	TMCO	415,421
Field Shunt Contactor	M	416,420
Field Shunt Relays	FS	416,420
Field Shunt Resistor		416
Voltage Regulator	VR	438
Wheel Slip Relay	WS	431
Wheel Slip Resistor		431

A I R S Y S T E M

CONTENTS

	Page
GENERAL DESCRIPTION	602
AIR COMPRESSOR	602
MAIN RESERVOIR SYSTEM	603
AIR BRAKE SYSTEM	603
SHUTTER CONTROL	604
SIGNAL PIPE	604
CONTROL AIR SYSTEM	604
ELECTRO-PNEUMATIC EQUIPMENT	605

AIR SYSTEM

GENERAL DESCRIPTION

This locomotive is equipped with an independent air system which is to be coupled with the air system of other units when in multiple operation. The air supply for the system is obtained from a two-stage air compressor, directly driven by the Diesel engine through an extension shaft. Air system is used for:

1. Air brakes
2. Controlling direction of travel and speed of locomotive
3. Sanding
4. Operating radiator shutters and controlling cooling fan speed
5. Signaling and air horns
6. Windshield wipers
7. Miscellaneous functions

The air system is inter-related with the electrical system. The electro-pneumatic equipment is tabulated on page 605 and Figure 1 is a schematic diagram of the air system of the locomotive.

AIR COMPRESSOR

The compressor is entirely air cooled and each cylinder is fitted with air cooling fins. The compressor is provided with its own lubricating system, including an oil pump, oil strainer and oil reservoir. The lower part of the crank case serves as an oil reservoir. Oil level within the crankcase should be checked daily with bayonet gauge installed in base of the compressor. Level of oil should be maintained within limits marked on gauge.

The compressor is equipped with a load and unload type magnet valve (see Compressor Valve, CV, Figure 1) for maintaining the pressures in the main reservoirs between the desired limits. When the Diesel engine is running and air in the main reservoirs is at desired pressure, unloading device allows the compressor to run without pumping air. Should air pressure, due to use

of air in the system, drop below desired limit, unloading device closes to load position and the compressor begins to pump air. Unloading device is actuated by an electro-pneumatic governor (S-16 Governor, Figure 1) set to load the compressor when pressure drops below 125 PSI. It unloads compressor when pressure in reservoirs rises above 140 PSI.

MAIN RESERVOIR SYSTEM

Compressed air is delivered from high pressure piston of the air compressor to main reservoir tanks. The tanks are inter-connected and have automatic drain valves installed in the lines for removing condensation. When units are coupled together, main reservoir systems of each unit are connected; should engine failure occur in one unit, compressors of remaining units will supply full air pressure to the system having a disabled compressor. Air for various systems not requiring 140 PSI is taken from main reservoir system through reducing valves. Where reducing valves are shown in Figure 1, reduction in pressure is indicated. Main reservoir system should be drained manually at regular intervals. Drains are located as shown on Figure 2, Section 1. Each unit has two tanks.

AIR BRAKE SYSTEM

A separate air brake cylinder is provided on each side of both trucks, operating brakes on the front and rear wheels of both trucks. Application and release operation of brake valves is relayed to the H-24-G Relay Air Valve (Figure 1). This valve reproduces in the brake cylinders an air pressure equivalent to the amount of brake application desired by the engineer. Locomotive is equipped with following air brake controls:

DSE-24 Brake Valve

DSE-24 Brake Valve is located in locomotive cab of "A" units only and is used to control operation of both train and locomotive air brakes.

S-40-F Brake Valve

S-40-F Brake Valve is situated in locomotive cab of "A" units only and is used to control operation of locomotive brakes independent of DS-24 Brake Valve.

Hostler's Valve

Hostler's Valve is located in "B" units only and is used to control air brakes of "B" unit when operated independently.

K-2 Rotair Valve

K-2 Rotair Valve is located at engineer's position in "A" unit cabs. This valve is a selector valve with three positions: freight, passenger and lap. The valve is placed in position depending upon type of service, whether freight or passenger. If valve is placed in "FRGT" or "PASS" position in operating cab, it must be in "LAP" position in non-operating cab.

SHUTTER CONTROL

A further reduction to 17 PSI is made to furnish low air pressure control to Grad-u-stat and pneumatic temperature switches in radiator cooling system. These air lines are shown in upper left portion of Figure 1.

SIGNAL PIPE

A reducing valve near the signal pipe at the right side of Figure 1 reduces the air pressure to 45 PSI for the signal system.

CONTROL AIR SYSTEM

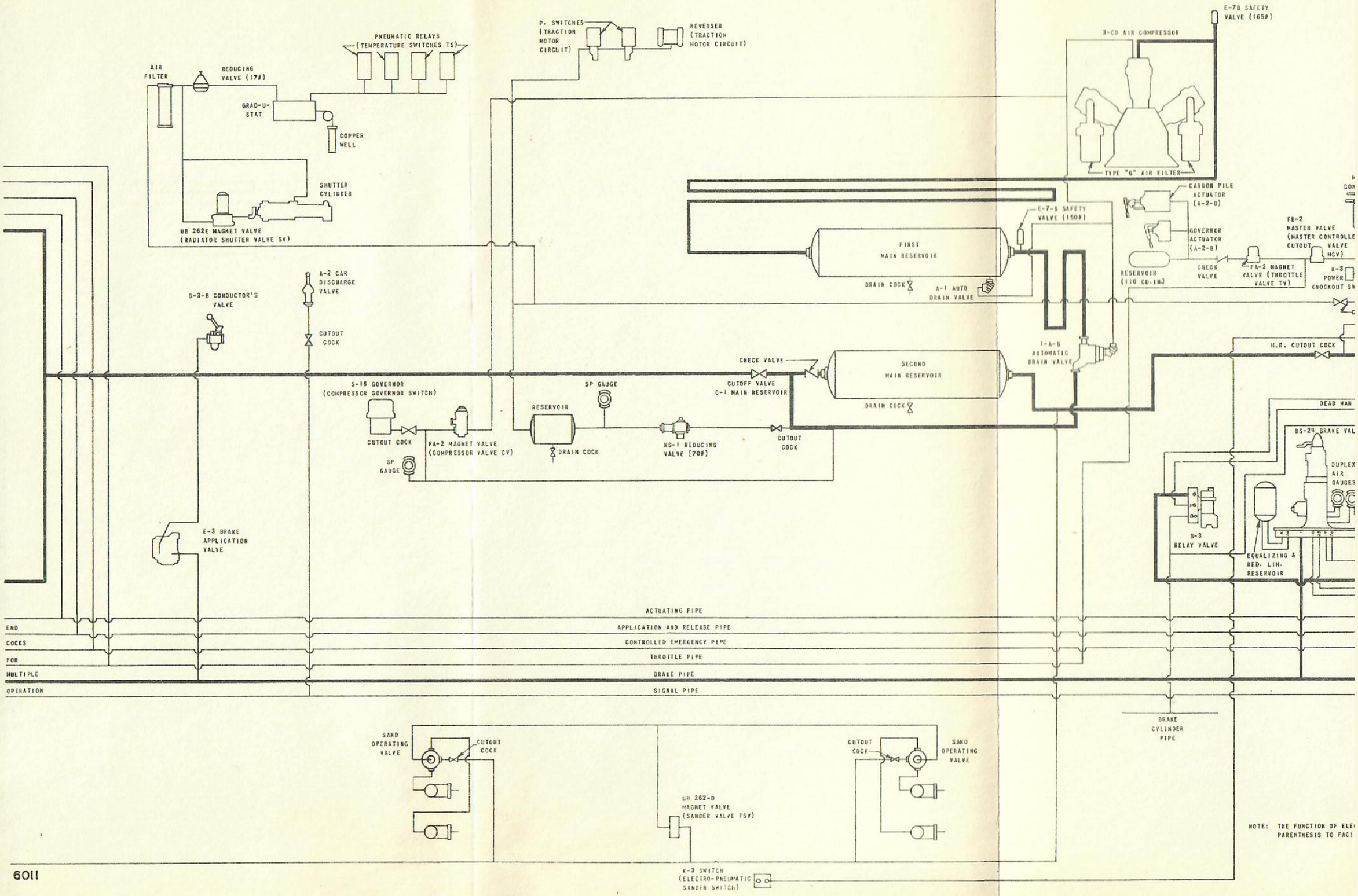
Air is taken from main reservoir, reduced to 70 PSI and led to the power switches (see Power Switch, Index, Section 4) and reverser (see Reverser, Index, Section 4) in power equipment cabinet. These switches and the reverser are pneumatically actuated. The 70 pound air is also led to the throttle valve on the master controller. Throttle determines speed of the locomotive. A reverse lever is incorporated into the master controller which determines direction of locomotive travel. Throttle feeds air to the governor and carbon pile actuators (A-2-B and A-2-G Actuators, Figure 1). These actuators are controlled by two magnet throttle valves (F-A-2 Magnet Valves).

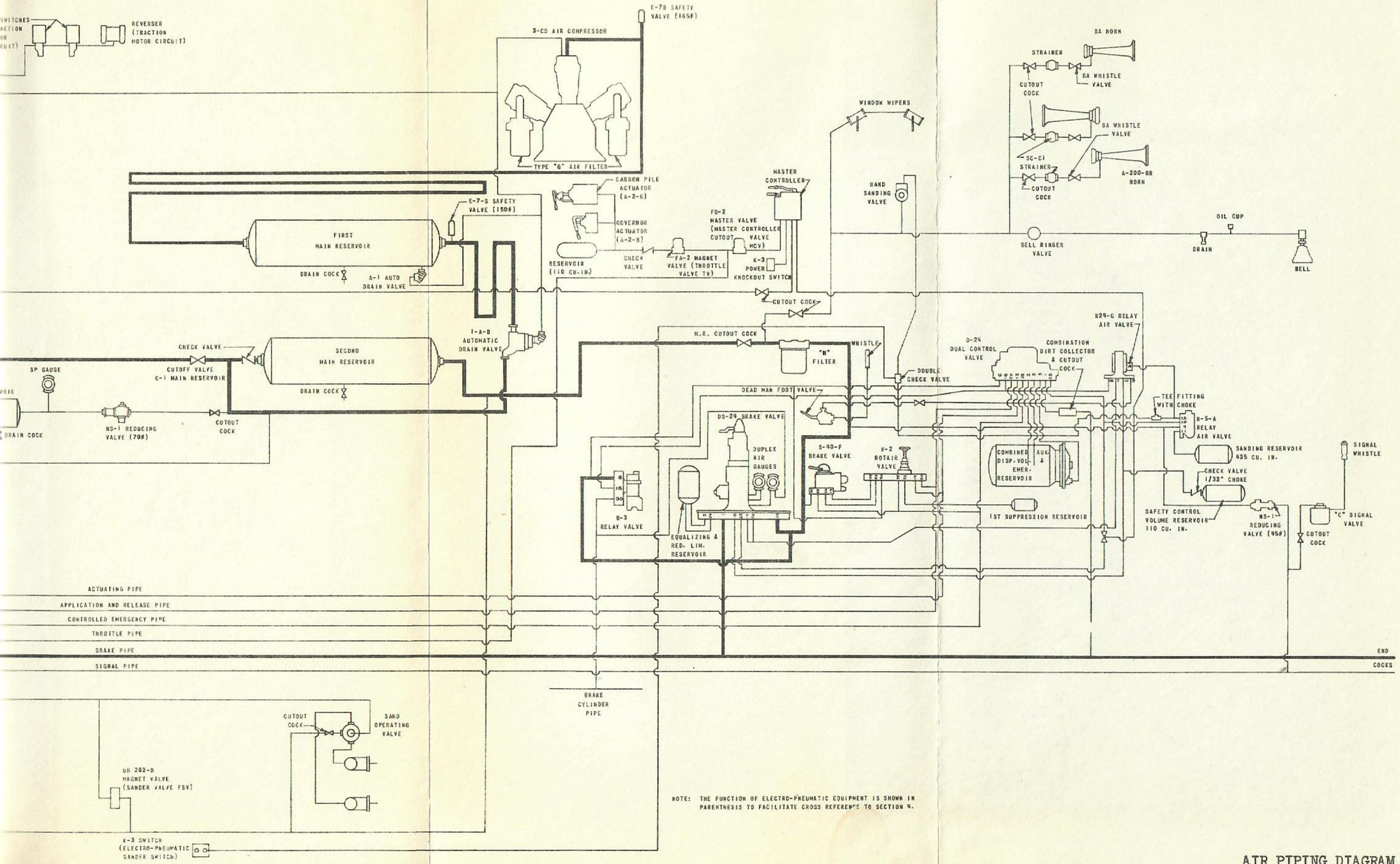
The electro-magnetic equipment tabulated below appears on the Air System diagram. Electrical functions of the equipment have been discussed in Section 4. Valves are actuated or controlled by electro-magnetic coils.

ELECTRO-PNEUMATIC EQUIPMENT

Electrical Symbol	Item	Function
FSV	Sander Valve; UB262D Valve	Controls air to forward sanders
K-3	Power Knockout Switch	Brings engine to idling when an emergency brake application is made or when deadman pedal is released
K-3	Sander Switch	Actuates FS or RS when hand sander lever is moved
MCV	Master Control Valve; UB262E Magnet Valve	Controls air supply to throttle valves to prevent accidental use of inactive throttles
TV	Throttle Valves; UB363C Magnet Valve	Electrically control air pressure to throttle lines
CV	Compressor Valve; FA2 Magnet Valve	Load and unload device actuator for air compressor
P	Power Switches	Connect traction motors to generators
	Reverser	Controls direction of rotation of traction motors
SV	Radiator Shutter Control Valve; UB262E Magnet Valve	Actuates fan and shutter mechanism for engine water temperature control

END
COCKS
FOR
MULTIPLE
OPERATION


AIR FILTER
REDUCING VALVE (17#)
PNEUMATIC RELAYS (TEMPERATURE SWITCHES TS)
GRAD-U-STAT
COPPER WELL
SHUTTER CYLINDER
UB 262E MAGNET VALVE (RADIATOR SHUTTER VALVE SV)
P. SWITCHES (TRACTION MOTOR CIRCUIT)
REVERSER (TRACTION MOTOR CIRCUIT)
E-7B SAFETY VALVE (165#)
3-CD AIR COMPRESSOR
TYPE "G" AIR FILTER
CARBON PILE ACTUATOR (A-2-B)
E-7-B SAFETY VALVE (150#)
GOVERNOR ACTUATOR (A-2-B)
FB-2 MASTER VALVE (MASTER CONTROLLE CUTOUT VALVE MCV)
FIRST MAIN RESERVOIR
DRAIN COCK
A-1 AUTO DRAIN VALVE
RESERVOIR (110 CU-IN)
CHECK VALVE
FA-2 MAGNET VALVE (THROTTLE VALVE TV)
K-3 POWER KNOCKOUT SW
A-2 CAR DISCHARGE VALVE
G-3-B CONDUCTOR'S VALVE
CUTOUT COCK
CHECK VALVE
SECOND MAIN RESERVOIR
1-A-B AUTOMATIC DRAIN VALVE
M.R. CUTOUT COCK
S-16 GOVERNOR (COMPRESSOR GOVERNOR SWITCH)
SP GAUGE
CUTOFF VALVE C-1 MAIN RESERVOIR
RESERVOIR
CUTOUT COCK
FA-2 MAGNET VALVE (COMPRESSOR VALVE CV)
DRAIN COCK
NS-1 REDUCING VALVE (70#)
CUTOUT COCK
SP GAUGE
DEAD MAN
DS-24 BRAKE VAL
DUPLEX AIR GAUGES
E-3 BRAKE APPLICATION VALVE
G-3 RELAY VALVE
EQUALIZING & RED. LIN. RESERVOIR
ACTUATING PIPE
END
APPLICATION AND RELEASE PIPE
COCKS
CONTROLLED EMERGENCY PIPE
FOR
THROTTLE PIPE
MULTIPLE
BRAKE PIPE
OPERATION
SIGNAL PIPE
BRAKE CYLINDER PIPE
SAND OPERATING VALVE
CUTOUT COCK
UB 262-D MAGNET VALVE (SANDER VALVE FSV)
CUTOUT COCK
SAND OPERATING VALVE
K-3 SWITCH (ELECTRO-PNEUMATIC SANDER SWITCH)
NOTE: THE FUNCTION OF ELE
PARENTHESIS TO FACI



NOTE: THE FUNCTION OF ELECTRO-PNEUMATIC EQUIPMENT IS SHOWN IN PARENTHESIS TO FACILITATE CROSS REFERENCE TO SECTION 4.

AIR PIPING DIAGRAM
Figure 1

STEAM GENERATOR

CONTENTS

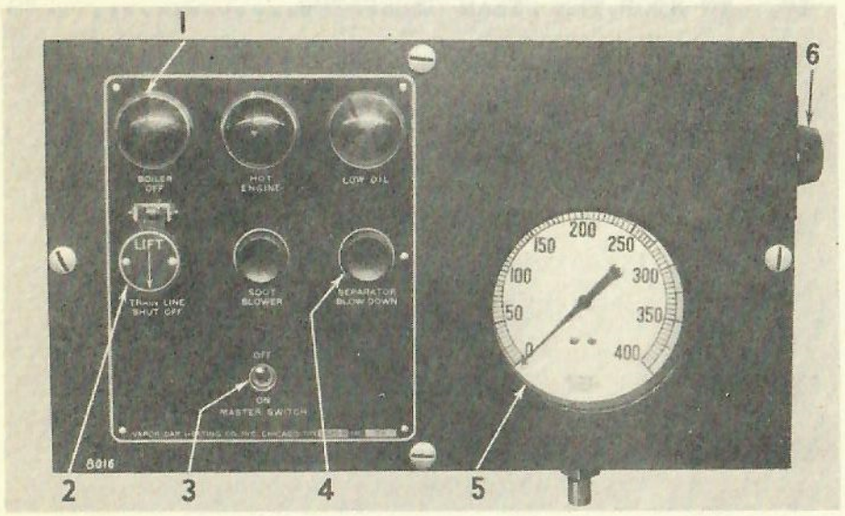
	Page
DESCRIPTION	802
OPERATION	803
I. BEFORE STARTING	803
II. STARTING	804
III. OPERATING	806
IV. TO STOP THE STEAM GENERATOR	807

S T E A M G E N E R A T O R

DESCRIPTION

The steam generator is fully automatic and will produce rated steam pressure within a few minutes after starting. The boiler is a continuous water tube type with forced circulation and is rated at 1600 pounds of water evaporation per hour. The boiler pressure is automatically held between 225 and 275 pounds by a back pressure regulator.

The steam passes through a steam separator where excess water is separated from the steam for return to the supply tank, and any solid particles are removed into a sump for periodic blowing out.



REMOTE CONTROL PANEL
Figure 1

A remote control panel is provided and is located at the fireman's position in the cab. It contains all the controls necessary for normal operation once the steam generator is started.

The following instruments and controls are located on this panel:

1. Boiler Off warning light.
2. Train Line Shut-Off.
   This is a push button switch with a protective cover to prevent shutting off the steam to the train line accidentally.
3. Master Switch.
   This is a toggle switch which lights the gauge light and provides current for the push button switches.
4. Separator Blowdown.
   This is a push button switch which opens the steam separator blowdown valve.
5. Train Line Steam Pressure Gauge.
6. Gauge Light Rheostat.
   Located on the right side of the panel and controls the amount of illumination of the gauge.

A "Boiler Off" warning light is located also on the rear wall of the engine room next to the main switch on "A" units.

O P E R A T I O N

I. BEFORE STARTING

A. Check that the following are open: water suction stop valve, coil shut-off valve, water inlet valve (9, Fig. 2) to water by-pass regulator, steam regulator stop valve, steam shut-off valve to diaphragm chamber of back pressure regulator, return water outlet valve at steam separator, water return valve in line to tank, and atomizing air admission valve. Also open pet cocks in steam lines to outfire control on control switch and to steam gauge.

B. Check that the following are closed: washout solution admission valve, washout solution return valve, manual water by-pass valve (8, Fig. 2), coil blowdown valve (8, Dia. A), water pump test valve (9, Dia. A) and all drain valves in the line between the water tank and the water pump.

C. See that motor reset button on the control cabinet is "in" (1, Fig. 2).

D. See that stack switch reset button is "in" (3, Dia. A).

E. See that the high temperature reset button is "in".

F. Set steam pressure switch at the desired maximum steam pressure, preferably not less than 160 pounds.

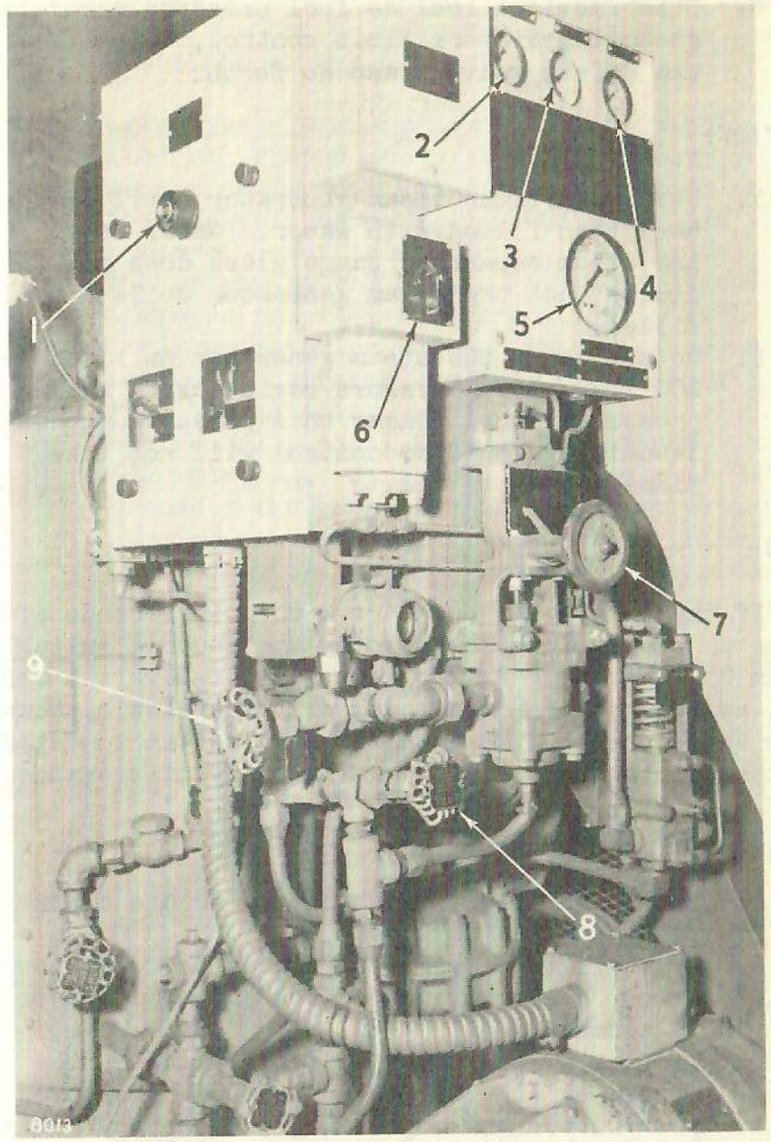
II. STARTING

A. Open separator blowdown valve (6, Dia. B). This valve is foot operated. Keep it open for about one minute to drain steam separator, then close valve.
B. Open fill-test valve (8, Dia. B).
C. Close main switch. The main switch is mounted on the rear wall of the "A" unit engine room, adjacent to the steam generator.
D. Turn control switch (6, Fig. 2) to "fill" position.
E. As soon as water has discharged from fill-test valve, close it. Open separator blowdown valve and turn control switch to "run" position.
F. When generator pressure builds up to 130 lbs. close separator blowdown valve.
G. Depress latching lever on train line shut-off valve. This will admit steam to the train line.
H. Set water by-pass regulator (7, Fig. 2) to required steam line pressure.
J. Before leaving the terminal, after starting the steam generator inspect the following pipe openings for leaks: separator blowdown (6, Dia. B), coil blowdown (8, Dia. A), water treater drain. If leaking see that valves are closed tight.

SAFETY DEVICES

The steam generator is protected by a number of automatic safeguards, provided to guard against possible damage, which shut down either the burner or the motor when conditions detrimental to safe operation of the generator arise.

1. Outfire Control: A steam pressure actuated latch to trip the control switch to "off" position and shut down the motor when the pressure drops below 160 lbs.
2. Servo-Fuel Control: Meters fuel to burner in proper relation to water entering coils; adjusts the air damper for good combustion throughout entire range of output.
3. Stack Switch: Stack temperature above 900° F. opens the switch and shuts down the motor.
4. Fuses: Two fuses are in the control circuit and two in the ignition circuit.



STEAM GENERATOR OPERATING CONTROLS
Figure 2

1. Reset Button
2. Air Pressure Gauge
3. Fuel Manifold Pressure Gauge
4. Fuel to Nozzle Pressure Gauge
5. Train Line Pressure Gauge
6. Control Switch
7. Water By-Pass Regulator
8. Manual Water By-Pass Valve (Closed)
9. Inlet Valve to Water By-Pass Regulator (Open)

5. Other devices include fuel pressure regulator, steam temperature limit control, steam pressure safety valves, and so forth.

CAUTION:

1. Never start the steam generator until the coils have been filled with water. Water level in the steam separator gauge glass does not indicate that the steam generator coils are filled.
2. Do not leave the steam generator until at least 200 lbs. steam pressure registers on boiler pressure gauge. Under this pressure automatic latching of outfire control will not take place.

NOTE:

If the fire fails to start within 45 seconds after going to the "start" position of the control switch (Item D), the motor will be shut down. Move the control switch to "off" and check all the reset buttons. They should be in. Move the control switch to "start". If the fire fails to start again notify maintenance.

III. OPERATING - AT FIREMAN'S POSITION

A. Turn the master switch on the remote control panel to the "on" position.
B. Approximately every hour press the steam separator blowdown push button and hold in for 10 seconds.
C. The train line steam shut-off valve can be closed by lifting the protecting cover over the push button and depressing the button. This will be necessary only when a car is to be cut out of the train.
D. After the train line steam shut-off valve has been closed it will be necessary to open the shut-off pilot valve manually at the steam generator by depressing the latching lever, to admit steam back into train line.

NOTE:

The diaphragm valve is a part of the train line shut-off valve assembly and is set fully open when in the open position. Do not attempt to regulate train

steam pressure with this valve. Throttle the steam supply within the train line stop valve on the steam generator when necessary.

E. Approximately every hour turn the handle on the fuel oil filter one full turn (5, Dia. B),
F. Periodically feel the feed water check valve, which should be warm. If too hot, this is because of insufficient fuel. A dirty fuel filter may be the cause. If the filter is O.K. increase the fuel pressure slightly with the fuel key metering valve. If the check valve is too cold, decrease the fuel pressure with the fuel key metering valve.
G. Periodically check the water pressure gauge (14, Dia. B). It should not read over 450 pounds. The gauge should be steady with no jumping action. Jumping action indicates vapor bound suction valves. Opening the air bleeder valves on the water pump suction valve caps should correct the trouble.
H. Empty the drip pan under the water pump packing as required. Slight leakage is normal.
J. The generator may shut down periodically lighting the "boiler off" warning light on the remote control panel and on rear wall of engine room. If the alarm bell is not ringing this is caused by the pressure reaching the pressure switch setting. The steam generator will start automatically when the pressure has dropped sufficiently.
K. If the generator should shut down and the alarm bell rings this will be caused by one of the protective devices operating. Turn the operating switch off. Check all reset buttons. If all the reset buttons are in, check fuses. If a reset button is out, refill the steam generator coils as outlined under STARTING, Item II, A to D above, then press the reset button in and restart the generator as outlined above. It may require 4 minutes time before the thermal elements in the protective devices cool to the point where the reset button will stay in.

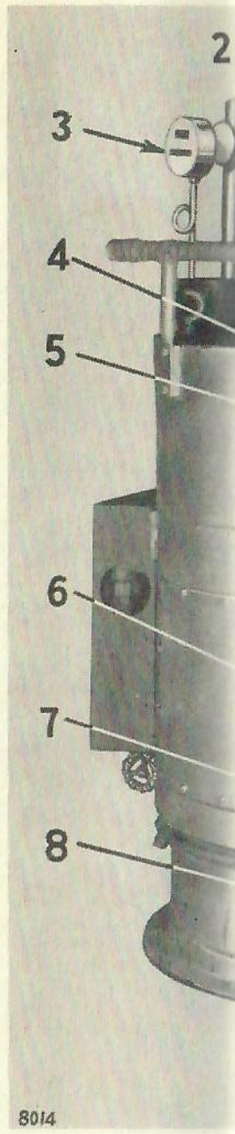
IV. TO STOP THE STEAM GENERATOR

A. Close the train line shut-off valve.
B. Close the stop valve.

C. Set the steam pressure switch up to 200 pounds.
D. At 200 pounds steam pressure. turn the operating switch to "off".
E. Open the coil blowdown valve (8, Dia. A). The knob on the valve must be pulled outward to release the handle for opening the valve.
F. Return the steam pressure switch to normal operating setting.
G. Close the atomizing air admission valve.
H. Turn the control switch to "off".
I. When the steam pressure drops to 50 pounds close the coil blowdown valve.
J. Open the separator blowdown valve (6, Dia. B) and blow down the steam separator with the remaining pressure.
K. Close the separator blowdown valve when all the steam pressure is gone.
L. Open the main switch.

NOTE:

This section outlines the operation of the train heating steam generator. For more complete instructions on servicing and maintaining the generator, see the Vapor Car Heating Co. instruction and maintenance manuals.



1. Fuel Spray
2. Control Cab
3. Stack Switc
4. Air Solenoi
5. Return Wate

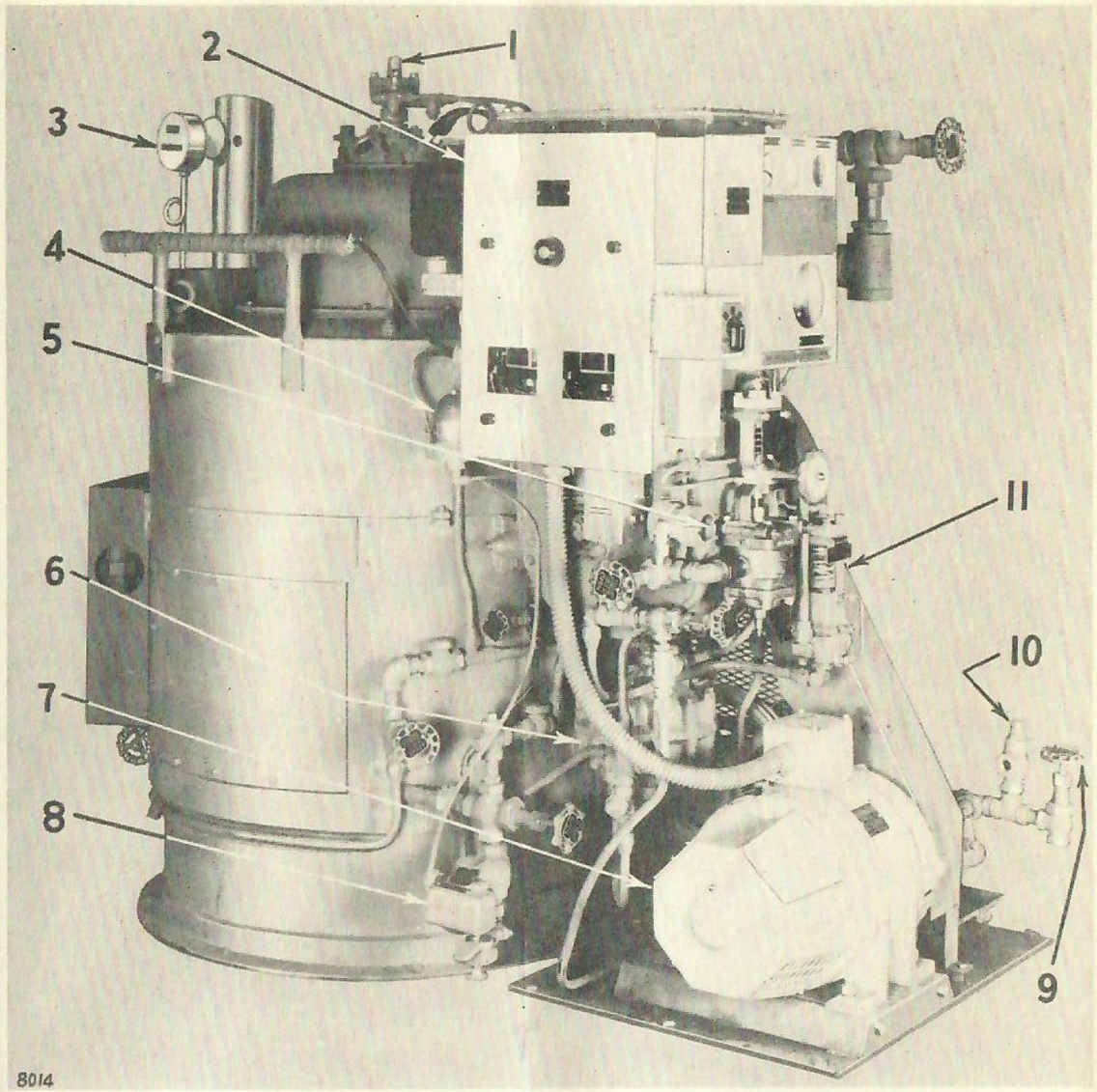


DIAGRAM A

1. Fuel Spray Head
2. Control Cabinet
3. Stack Switch Reset Button
4. Air Solenoid Valve
5. Return Water Flow Indicator
6. Motor Convertor
7. Heat Exchanger
8. Coil Blowdown Valve
9. Water Pump Test Valve (Closed)
10. Water Relief Valve
11. Water By-Pass Control

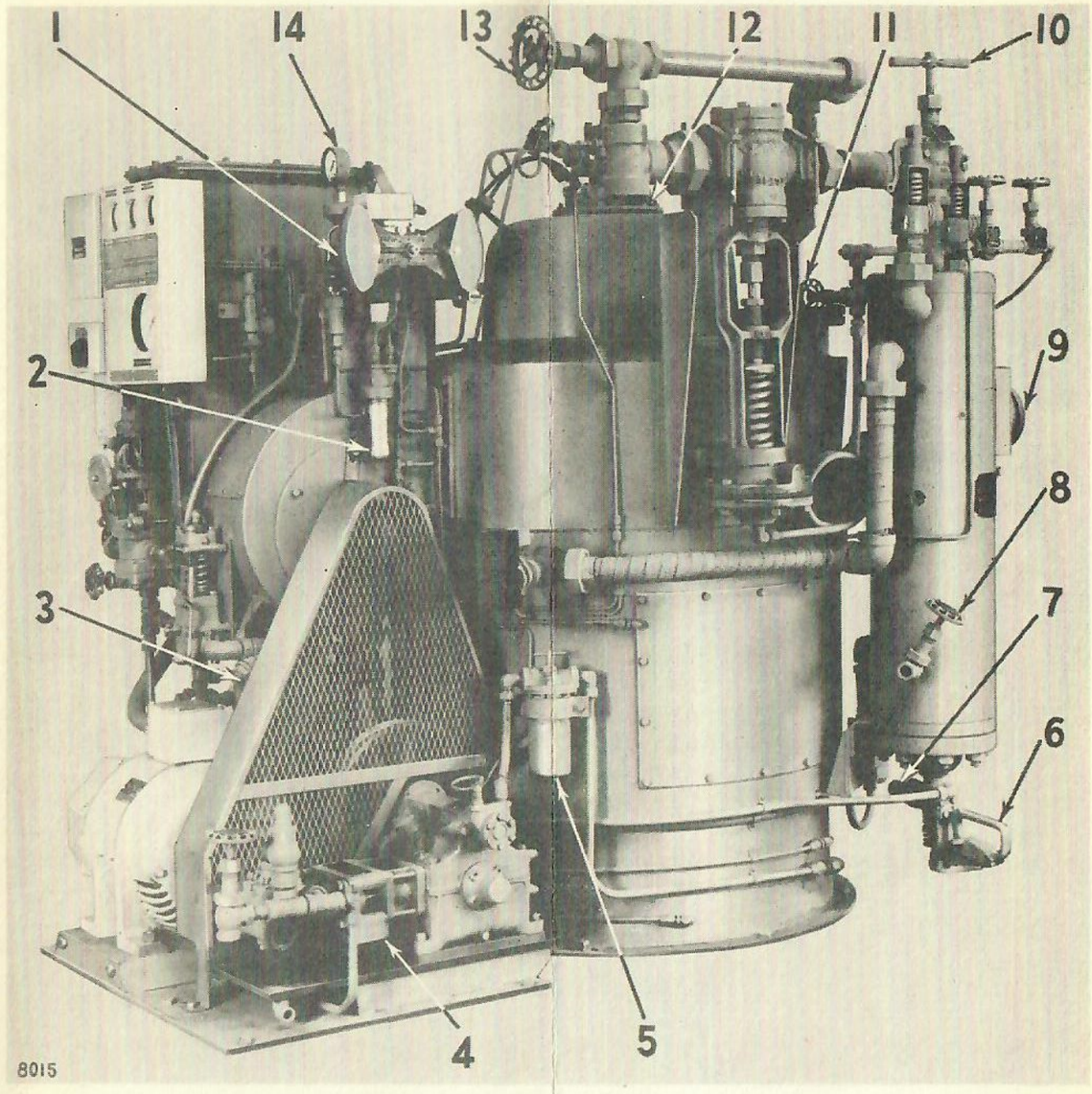
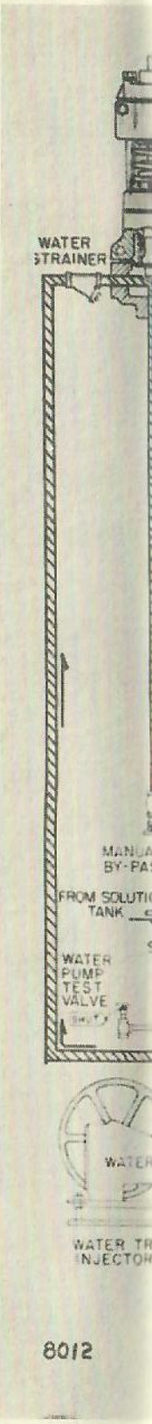


DIAGRAM B

1. Servo Control
2. Fuel Pressure Filter
3. Water Strainer
4. Water Pump
5. Fuel Suction Filter
6. Separator Blowdown Valve
7. Steam Trap
8. Fill Test Valve (Closed)
9. Generator Pressure Gauge
10. Separator Stop Valve (Closed)
11. Back Pressure Regulator Diaphragm Shut-Off Valve (Open)
12. Peep Hole
13. Emergency By-Pass Valve
14. Water Pressure Gauge

VIEWS OF STEAM GENERATOR
Figure 3


WATER
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VALVE
WATER TR
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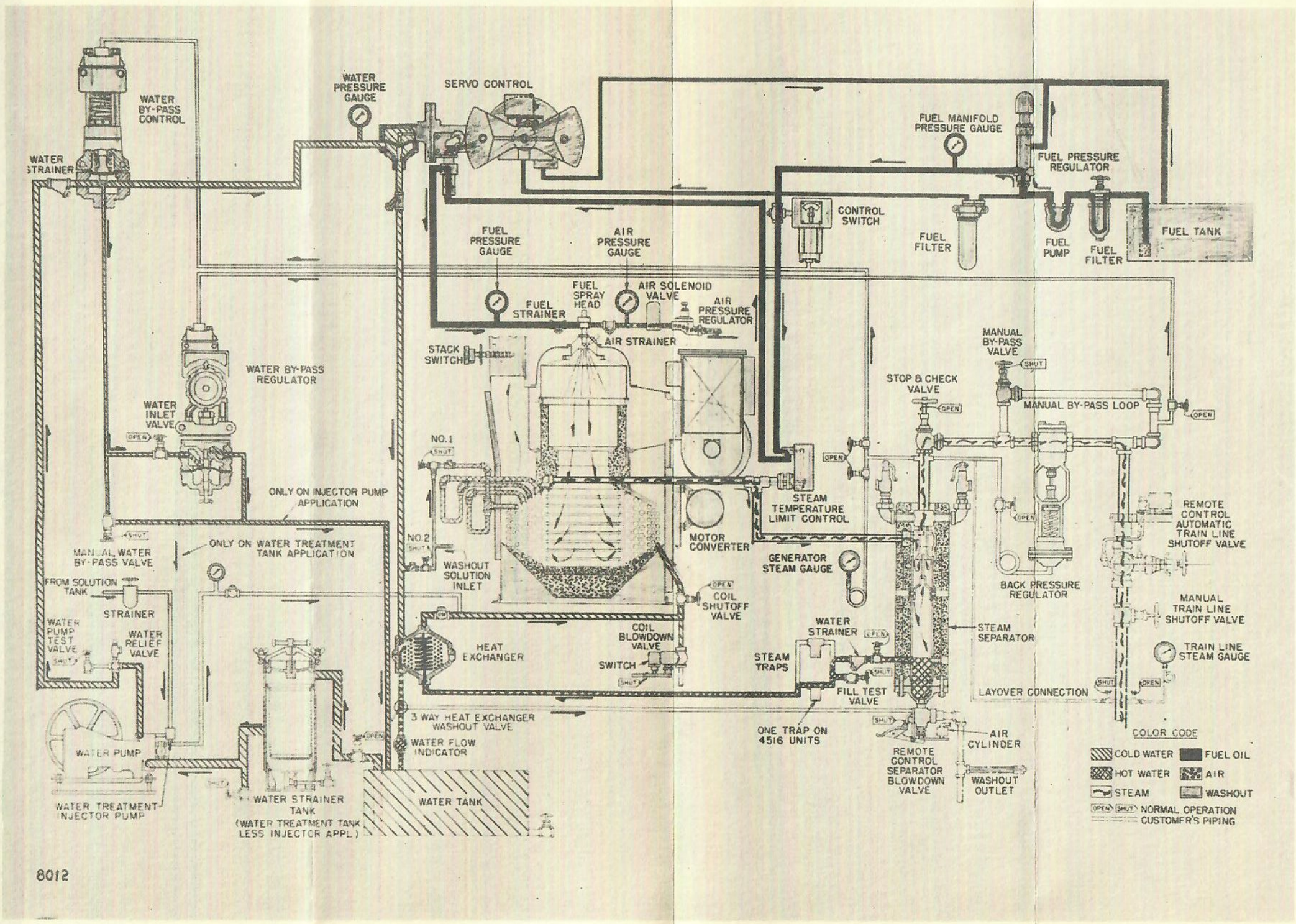

STEAM GENERATOR - SCHEMATIC DIAGRAM
Figure 4